Storm Water Education Task Force Presentation Manual

Hamilton County, Ohio

Planning Partnership

HAMILTON COUNTY
Regional
Planning
Commission

Revised August 2002

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Acknowledgements

Special thanks to the following members of the Storm Water Education Task Force who have devoted significant time and resources to completing this manual and who have agreed to make the presentations to the 49 political jurisdictions within Hamilton County.

- Brian Bohl, Hamilton County Soil and Water Conservation District
- Robin Corathers, Mill Creek Restoration Project
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The Planning Partnership
Hamilton County Regional Planning Commission

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NACo National Association of Counties

June 13, 2003

Catalina Landivar-Simon
Senior Planner
Planning Partnership Services
138 E. Court St., Rm 807
Cincinnati, OH 45202

Dear Catalina:

Congratulations! I am pleased to announce that your county has been awarded a 2003 NACo Achievement Award for the program entitled, **The Planning Partnership - Stormwater Management Program.** In this 34th year of the Achievement Award program, NACo is extremely pleased with the high caliber of county programs and projects. NACo is proud to confer this award and recognize your county's hard work to promote responsible, responsive, and effective county government.

NACo greatly appreciates your county's participation in our Achievement Award program. In addition to giving us an opportunity to formally recognize effective and creative programs, this program enhances our awareness of county activities and allows us to share valuable information with other counties throughout the nation.

As you may know, NACo recognizes award winners in several ways. A list of winning programs will be available on NACo's homepage at http://www.naco.org. Summaries of award winning programs will be included in our Model County Programs database on our website at:
http://www.naco.org/Template.cfm?Section=Model_County_Programs.
In addition, over the next several months, selections of award winning programs will be highlighted in *County News* in the column, "Hats Off."

We also offer a variety of commemorative items to help your county and the winning programs' employees celebrate its winning efforts. A new website, www.nacostore.com has been made available for these commemoratives to make purchasing efficient and easy.

This year, NACo will host the Seventh Annual Awards Reception during our 2003 Annual Conference in Milwaukee (Milwaukee County), Wisconsin. This luncheon, scheduled for the morning of Sunday, July 13, 2003, will be held from 11:30 a.m. – 1:30 p.m. in Room 203 B&C of the Midwest Airlines Center located at 400 West Wisconsin Avenue. During this ceremony, Achievement Award winners will be collectively recognized and there will be an opportunity for you or your representative to have a photo taken with a NACo official. We hope you will be able to attend. Enclosed is your official invitation to the reception. Please RSVP to Scott Felix at 202-942-4279 or email at sfelix@naco.org by July 2, if you plan to join us.

Questions concerning the award program may be directed to Joseph Hansen, research assistant or Jacqueline Byers, director of research at 202-661-8834 or 202-942-4285, respectively.

Congratulations on your county's accomplishment!

Sincerely,

Larry C. Naake

Larry Naake
Executive Director

Enclosures

440 First Street, NW
Washington, DC 20001-2080
202/393-6226
Fax 202/393-2630
www.naco.org

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National Association of Counties
2003 Achievement Award Winner

This Award is Presented to

Hamilton County, OH

for
its program

The Planning Partnership - Stormwater Management Program

in recognition of an innovative program
which contributes to and enhances county government in the United States.

Kenneth A. Mayfield
President

NACO National Association of Counties
Counties Care for America

Larry Naake
Executive Director

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Revised Printing, August 2002

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Section I

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Storm Water Management and Development Site Planning

Planning Partnership of the Hamilton County Regional Planning Commission:

Storm Water Education Task Force

Why we are here:

Storm Water Education Task Force

Purpose:

To develop an educational program for all planning commissions and zoning boards within Hamilton County on storm water issues related to the NPDES* Phase II permit requirements.

*National Pollutant Discharge Elimination System

Storm Water Education Task Force

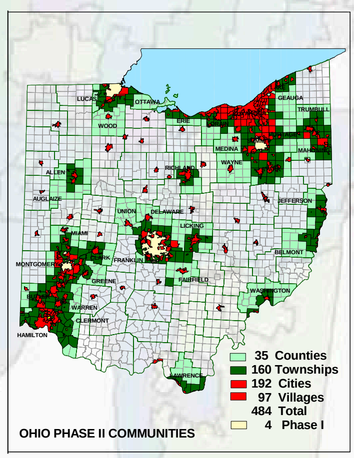
- Subcommittee of the Planning Partnership of the Hamilton County Planning Commission
- Task Force Member Affiliations:
  - Planning Partnership of the Hamilton County Regional Planning Commission
  - Hamilton County Soil & Water Conservation District
  - Hamilton County Wet Weather Initiative
  - Mill Creek Restoration Project
  - Mill Creek Watershed Council
  - FMSM Engineers Inc.
  - CDS Associates Inc.

NPDES Phase II Storm Water Permit Program

- Results from the 1972 Clean Water Act
- Purpose is to protect and improve the quality of rivers, streams and lakes from “non-point” sources
  - Chemicals washed off streets, parking lots and lawns by rainfall
  - Sediment and waste from construction sites or stream bank erosion
  - Runoff from agricultural activities
  - Illicit discharges to storm drains
  - Failing septic systems

NPDES* Phase II Storm Water Permit Program

- Facilitates and promotes regional watershed planning
- Regulates construction activities for sites greater than one acre
- Affects most urbanized areas in the State of Ohio



* National Pollutant Discharge Elimination System

Phase II Storm Water Regulations: Six Minimum Control Measures

1. Public education and outreach
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Construction site storm water runoff control
5. Post-construction management
6. Pollution prevention/good housekeeping

How will it affect my community?

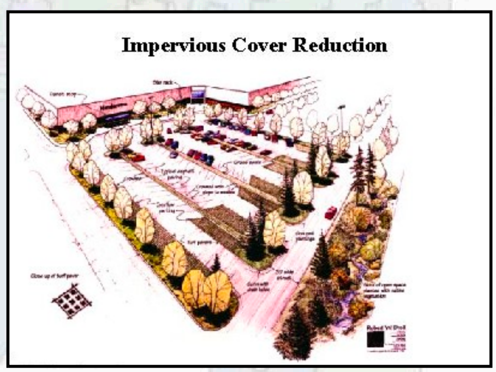
- Local governments must submit permit application and implementation plan to Ohio EPA by March 10, 2003.
- Requires improved ordinances for erosion & sediment control and illicit discharges.
- Requires implementation of storm water best management practices (BMP's).
- Requires improving site development and watershed protection techniques.

Basic Definitions

- **Storm water** – Precipitation or rainfall that does not infiltrate into the ground or evaporate into the air.
- **Runoff** - Storm water, and associated substances, discharged into streams, lakes, sewers or storm drains.
- **Watershed** - Land area from which water drains toward a common surface water body in a natural basin.

Basic Definitions - Continued

- **Imperviousness** – Portion of a watershed that is covered by surfaces (parking lots, roads, roof tops) that will not absorb rainfall.
- **Best management practices (BMPs)** - Any means, practice or technique to significantly reduce or eliminate storm water pollution.



General Site Development Principles

- A developed area should behave hydrologically as it did before the site was developed.

  (The amount of storm water leaving site should not increase after development.)

- The developer should seek to use the site's natural features, protect sensitive areas and limit imperviousness.

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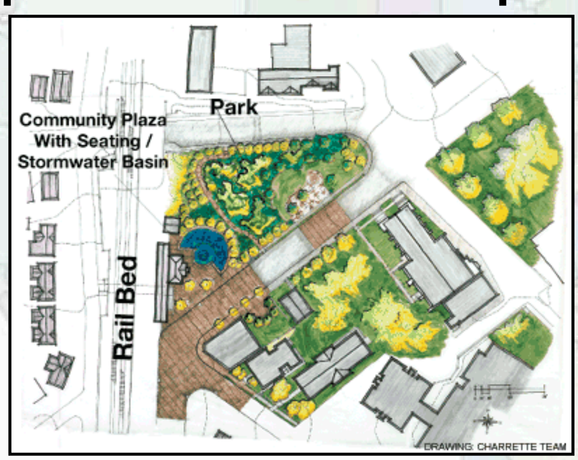
Twelve Principles for Responsible Site Development*



*Principles adapted from a presentation titled "Basic Principles of Site Planning and Stormwater Management" created on July 27, 1999 by James L. Smoot at University of Tennessee, College of Engineering.

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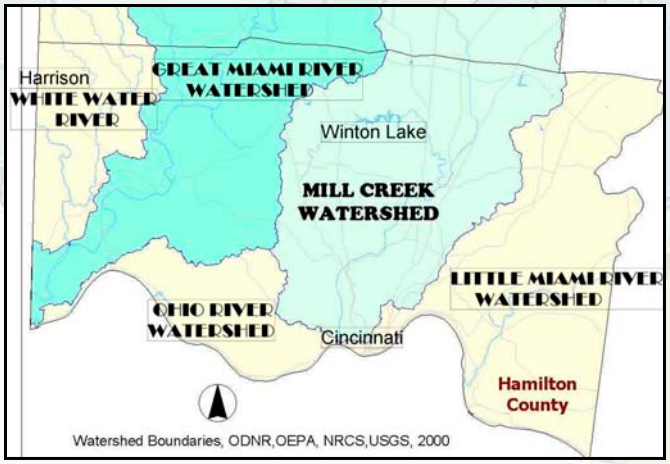
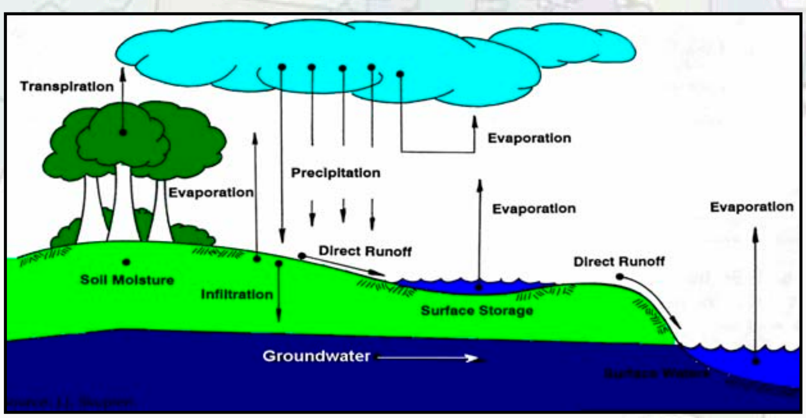
Principle One

Each parcel of land is part of a much larger watershed.



Principle Two

Storm water is an important natural resource that should be used to replenish our rivers, streams and lakes.



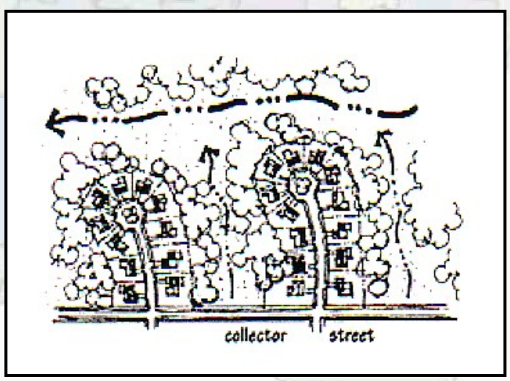
Principle Three

It is generally more efficient and cost-effective to prevent problems rather than attempt to correct them after the fact.

Principle Four

The final design of a storm water management system should attempt to mimic and use the natural drainage features of the site.

(This is usually the most cost-effective and lower maintenance option.)



Principle Five

Post-development runoff characteristics (volume, rate, timing and pollutant load) for a given site should closely resemble predevelopment conditions.

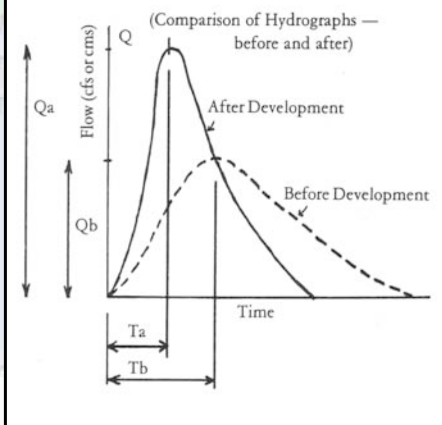


FIGURE 7-1
RUNOFF HYDROGRAPHS SHOWING EFFECTS OF URBANIZATION

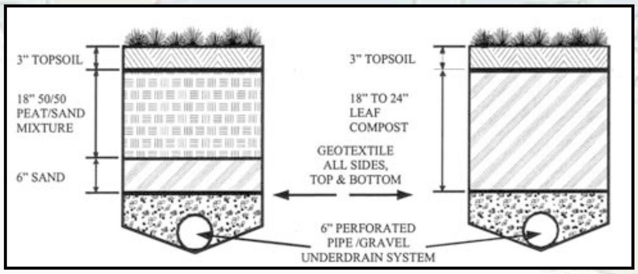
Principle Six

- The final site design should maximize on-site storage, infiltration & evaporation of storm water.

  (Remember, storm water is a resource.)
- Consideration should also be given to neighborhood or regional storage.

Storm Water BMP: On-Site Infiltration Trench

Designed to encourage reduction of runoff pollutant load and groundwater recharge.



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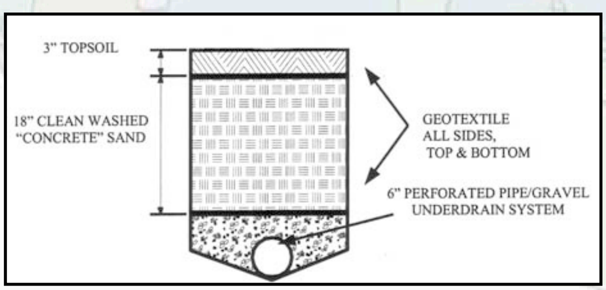
Storm Water BMP: On-Site Sand Filter

Designed to address pollutant load in runoff and encourage ground water recharge.



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Principle Seven

When possible, avoid discharging storm water directly to a surface water body such as a stream.

(Try to incorporate BMPs that slow down or reduce the storm water pollutant load before it is discharged to the environment.)

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Storm Water BMP: Vegetated Island

Vegetated parking lot islands are designed to allow infiltration of parking lot runoff.

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Storm Water BMP: Wetland

On-site wetland constructed to slow down storm water runoff and reduce pollutant load.

Before After Photos: Iowa State University Department of Forestry

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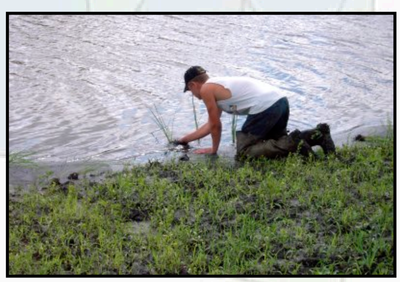
Principle Eight

Storm water management systems (particularly methods that use vegetation as a key component) should be designed, constructed and stabilized before the facilities that discharge to them are built.



Photos from website of Marten son and Eisele, Inc. Metzig Hills subdivision

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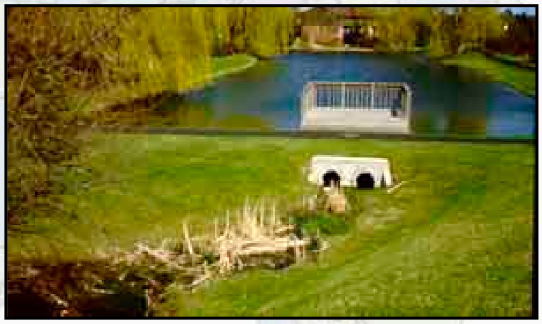
Principle Nine

Begin at the "end of the pipe," the receiving stream.

(Understand where the storm water from the site will discharge and how it will impact downstream areas before design of the storm water system.)



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Principle Ten

Design and construct, to the extent possible, the storm water management system along natural site contours.

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Principle Eleven

Vegetated buffer strips (riparian corridors) should be retained or created along banks of streams or lakes.

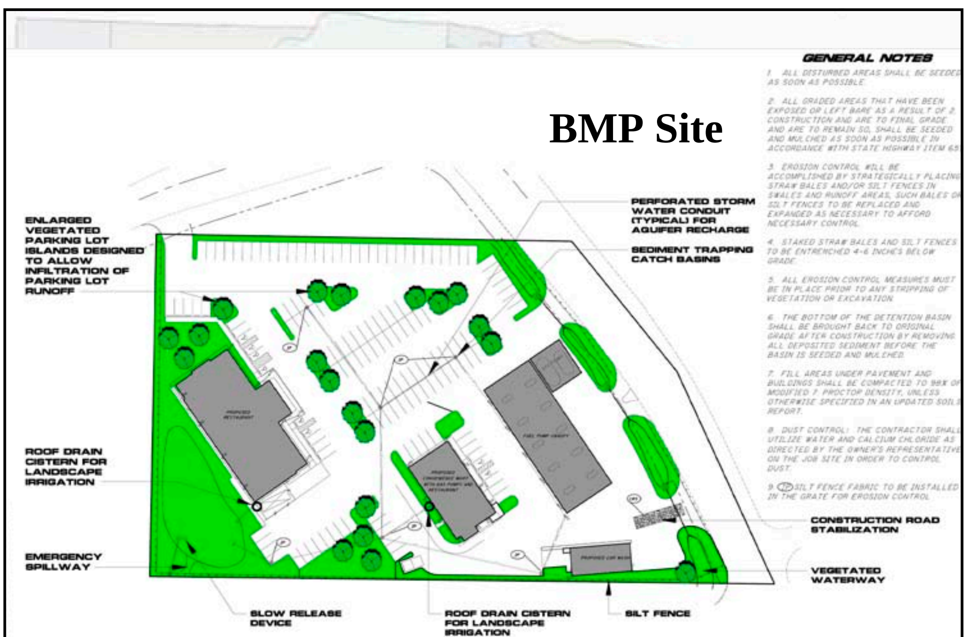
Principle Twelve

Regular inspection and maintenance is a key component of a storm water management system!

Site Development and Storm Water Management

Case Studies

Prior Site



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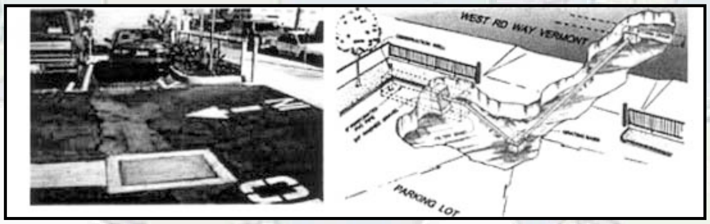
Stormwater BMPs

Perforated stormwater conduit to encourage groundwater recharge



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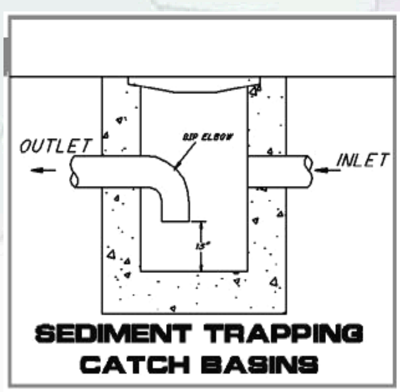
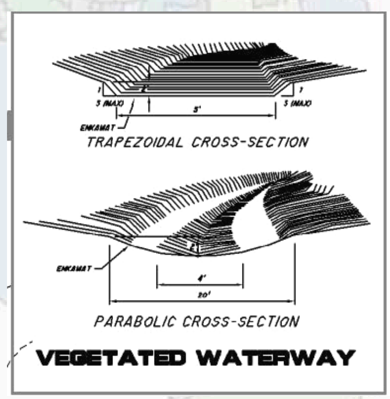
Stormwater BMPs

Sediment trapping catch basins

Vegetated swale (waterway)





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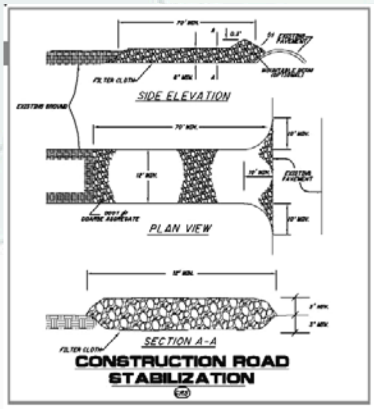
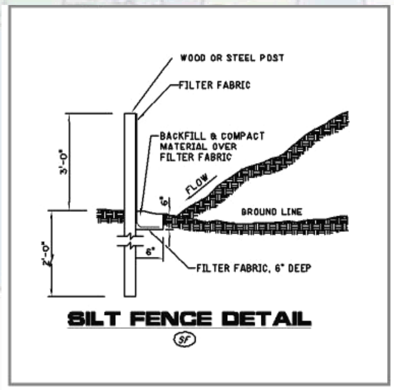
Stormwater BMPs

Construction road stabilization

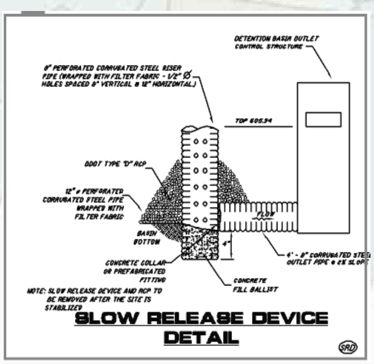


Silt fence

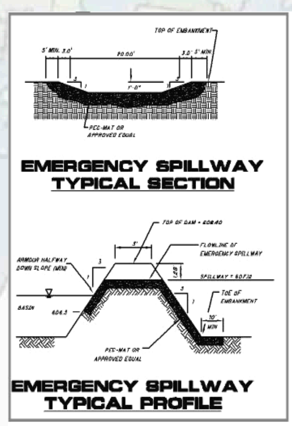


Stormwater BMPs

Slow release device detail

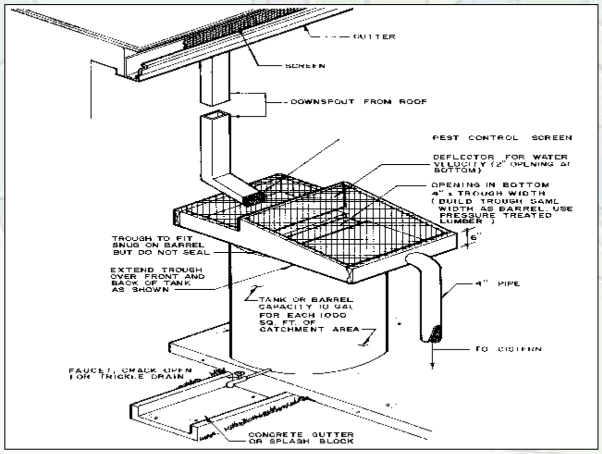


Emergency spillway



Stormwater BMPs

Roof drain cisterns for landscape irrigation



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Stormwater BMPs

Enlarged vegetated parking lot islands to encourage infiltration of runoff

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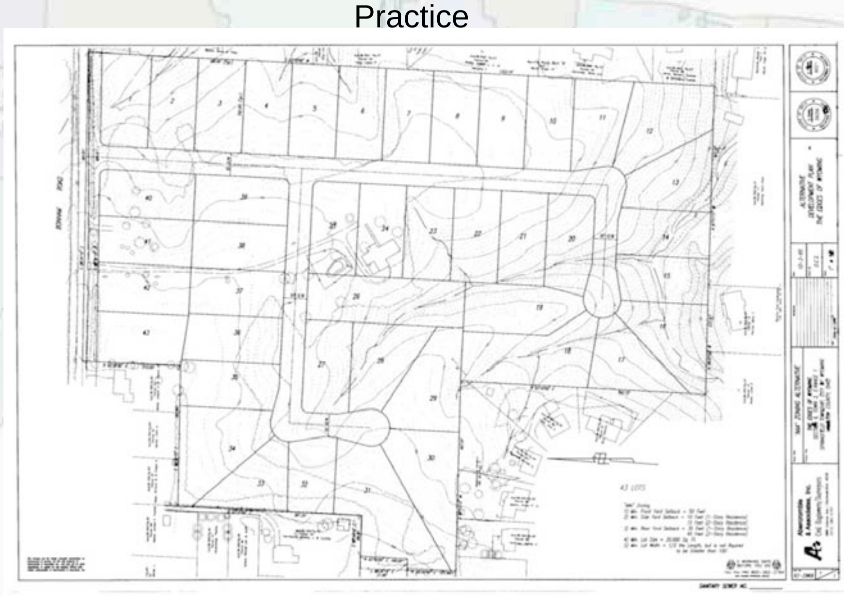
Residential Case Study: Standard Practice



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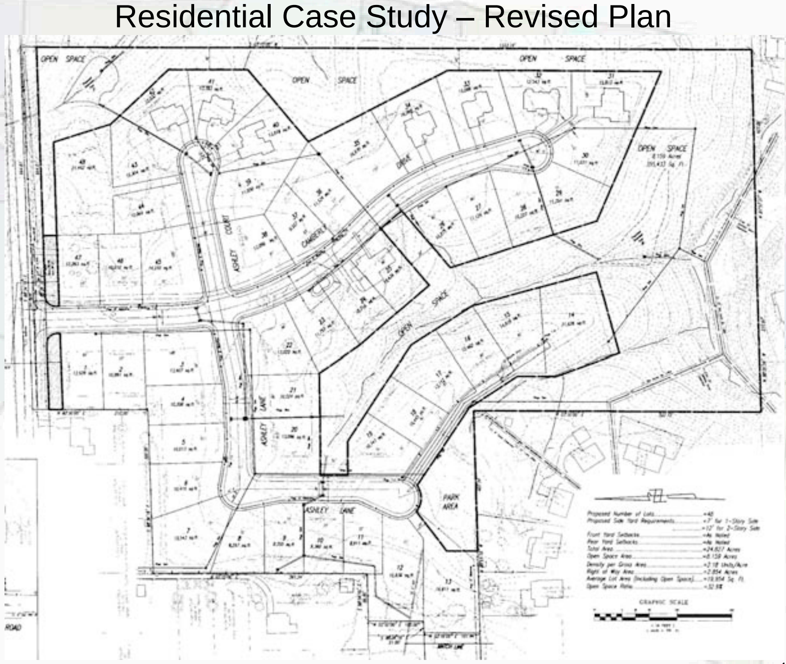
Residential Case Study – Revised Plan



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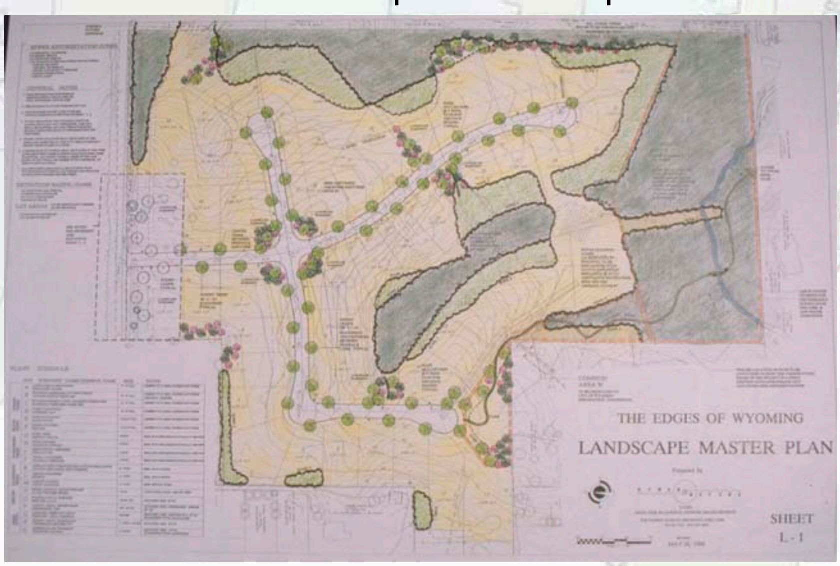
Implemented Stormwater BMPs

Principles 3 & 8: Constructed stormwater management features (detention basins) before building

Principles 3 & 7: Used detention basins as temporary sedimentation basins

Use smaller lot sizes to preserve open space

Residential Example: Landscape Plan



Implemented Stormwater BMPs

Principle 10: Preserved natural site contours

Principle 11: Protected riparian corridors

Principles 6 & 7: Downspouts discharge on grade (onto the lawns)

Remember, storm water is a <u>resource</u>!

This presentation has been developed as an educational tool on stormwater management. The presentation is a compilation and adaptation from works from different authors, including "Basic Principles of Site Planning and Stormwater Management" created on July 27, 1999 by James L. Smoot at University of Tennessee, College of Engineering.

References and Citations

- “Basic Principles of Site Planning and Stormwater Management” created on July 27, 1999 by James L. Smoot at University of Tennessee, College of Engineering
  James L. Smoot, PhD, PE
  Assistant Regional Hydrologist - NAWQA
  U.S. Geological Survey
  3850 Holcomb Bridge Road, Suite 160
  Norcross, Georgia 30092-5223
  Office Phone: 770-409-7724
  Cell Phone: 404-452-9220
  FAX: 770-409-7725
  Office E-Mail: jlsmoot@usgs.gov
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- “Hamilton County Storm Water Study”, Metropolitan Sewer District of Greater Cincinnati, Feb. 6, 2002

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Section II

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SITE PLAN

GENERAL NOTES

1. ALL DISTURBED AREAS SHALL BE SEEDED AS SOON AS POSSIBLE.

2. ALL GRADED AREAS THAT HAVE BEEN EXPOSED OR LEFT BARE AS A RESULT OF 2. CONSTRUCTION AND ARE TO FINAL GRADE AND ARE TO REMAIN SO, SHALL BE SEEDED AND MULCHED AS SOON AS POSSIBLE IN ACCORDANCE WITH STATE HIGHWAY ITEM 659

3. EROSION CONTROL WILL BE ACCOMPLISHED BY STRATEGICALLY PLACING STRAW BALES AND/OR SILT FENCES IN SWALES AND RUNOFF AREAS, SUCH BALES OR SILT FENCES TO BE REPLACED AND EXPANDED AS NECESSARY TO AFFORD NECESSARY CONTROL.

4. STAKED STRAW BALES AND SILT FENCES TO BE ENTRENCHED 4-6 INCHES BELOW GRADE.

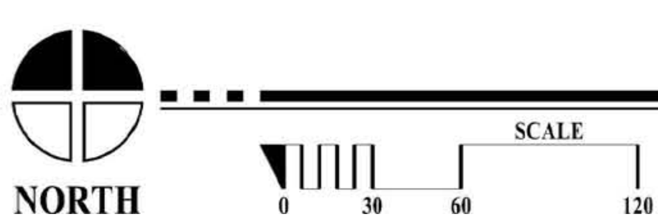
5. ALL EROSION CONTROL MEASURES MUST BE IN PLACE PRIOR TO ANY STRIPPING OF VEGETATION OR EXCAVATION.

6. THE BOTTOM OF THE DETENTION BASIN SHALL BE BROUGHT BACK TO ORIGINAL GRADE AFTER CONSTRUCTION BY REMOVING ALL DEPOSITED SEDIMENT BEFORE THE BASIN IS SEEDED AND MULCHED.

7. FILL AREAS UNDER PAVEMENT AND BUILDINGS SHALL BE COMPACTED TO 98% OF MODIFIED 7. PROCTOR DENSITY, UNLESS OTHERWISE SPECIFIED IN AN UPDATED SOILS REPORT.

8. DUST CONTROL: THE CONTRACTOR SHALL UTILIZE WATER AND CALCIUM CHLORIDE AS DIRECTED BY THE OWNER'S REPRESENTATIVE ON THE JOB SITE IN ORDER TO CONTROL DUST.

9. IP SILT FENCE FABRIC TO BE INSTALLED IN THE GRATE FOR EROSION CONTROL



CDS engineers architects planners surveyors

July 1, 2002

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Section III

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Twelve Site Development Principles

1. Each parcel of land is part of a much larger watershed.

2. Storm water is an important natural resource that should be used to replenish our rivers, streams and lakes.

3. It is generally more efficient and cost-effective to prevent problems rather than attempt to correct them after the fact.

4. The final design of a storm water management system should attempt to mimic and use the natural drainage features of the site.

5. Post-development runoff characteristics (volume, rate, timing and pollutant load) for a given site should closely resemble predevelopment conditions.

6. The final site design should maximize on-site storage, infiltration & evaporation of storm water. (Remember, storm water is a resource.)

7. When possible, avoid discharging storm water <u>directly</u> to a surface water body such as a stream.

8. Storm water management systems (particularly methods that use vegetation as a key component) should be designed, constructed and stabilized <u>before</u> the facilities that discharge to them are built.

9. Begin at the "end of the pipe," the receiving stream.

10. Design and construct, to the extent possible, the storm water management system along natural site contours.

11. Vegetated buffer strips should be retained or created along banks of stream or lakes.

12. Regular inspection and maintenance is a key component of a storm water management system!

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Section IV

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[c] BMPs highlighted on commercial site case study diagram.

* Unless otherwise noted, all photos and information have been obtained from the Center for Watershed Protection website at http://www.stormwatercenter.net.

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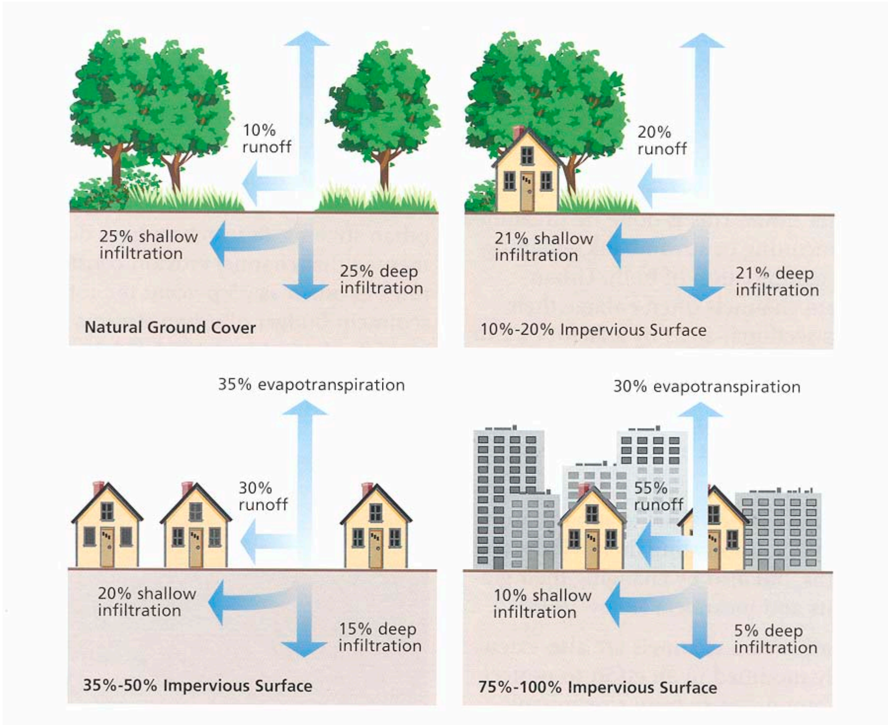
Storm Water Best Management Practices (BMPs) for Residential and Commercial Development Sites

Critical BMPs to Consider Prior to Site Development:

Sketch of a typical riparian forest buffer (Source: Chesapeake Bay Program, 2000)

Riparian area: The riparian area or forested buffer strip is perhaps the most important best management practice as it represents the "last line of defense" with respect to storm water impact on stream systems. Maintaining forested buffers along streams, rivers, and other water bodies is important as they are designed to remove pollutants associated with urban runoff. Removal occurs primarily through filtration of sediments, nutrients, and contaminants that would normally enter the stream system if directly discharged. Riparian areas also regulate the amount of water that enters a stream system through infiltration, and can play a crucial role in flood reduction. As a general practice, riparian areas should be 3 times the channel width, as measured from the top of the stream bank or 50 feet, whichever is greater.



Source: Federal Interagency Stream Restoration Working Group, 1998

Reduced impervious surface: When a land site is zoned for residential housing or commercial businesses, cleared, and built upon, the resultant land alteration can lead to dramatic hydrological changes. Hydrological change refers to the manner in which water is transported and stored. Impervious surfaces (asphalt, concrete, rooftops) and earth that have been compacted through development, create a barrier to the percolation of rain water into the soil. The disruption of the natural water cycle creates a number of changes in the watershed:

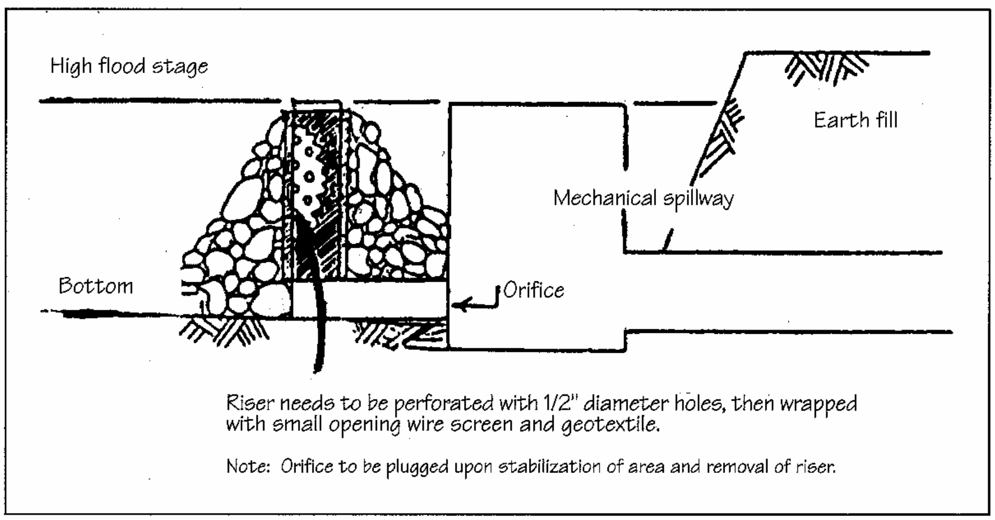
- Increased volume and velocity of runoff.
- Increased frequency and severity of flooding.
- Flows of peak storm events are many times greater than natural basins.
- Decrease in natural runoff storage capacity in vegetation, wetland, and soil of the site.
- Reduced groundwater recharge.
- Decreased groundwater contribution to stream systems. This results in intermittent or dry streams with increased temperatures and decreased dissolved oxygen levels.

The degree of watershed imperviousness directly influences urban streams as the annual volume of storm water runoff can increase by 2 to 16 times the predevelopment rate. In many regions of the country, as little as 10 percent watershed imperviousness leads to stream degradation (see figure above).

Construction Site BMPs:

Sediment basins are used to trap sediments and temporarily detain runoff on larger construction sites

Sediment basin: A sediment basin is constructed to retain sediment during construction activities. The basin should be designed using the natural contours in such a manner to capture the maximum amount of sediment and storm water flowing off a site. Storm water management storage basins should be the first erosion or sediment control practice installed on a new construction site. The sediment basin should be cleaned out after construction and periodically throughout the life of the basin as sediment and debris will accumulate over time. Additionally, an emergency spillway should be included in the basin design to allow excess storm water to flow out of the basin and prevent on-site flooding during extremely heavy rain events.

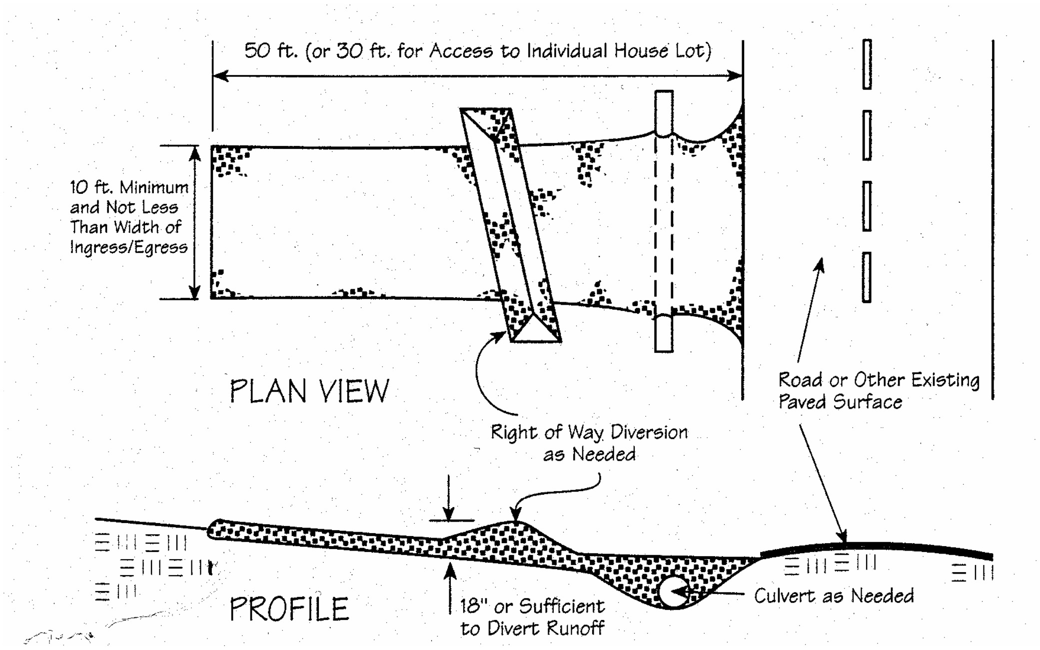


Source: Soil & Water Conservation Districts of Southwest Ohio

Slow release device: A slow release device is a mechanical structure installed at the outlet of a retention or detention basin to temporarily store storm water. The basin then functions as a temporary sediment trap. The slow release device is designed to allow stored water to drain slowly from the basin, causing sediment to settle out of the water. After construction, the slow release device is removed. Accumulated sediment is then cleaned out to restore the basin back to its intended design capacity.

Silt fences prevent the offsite transport of sediment

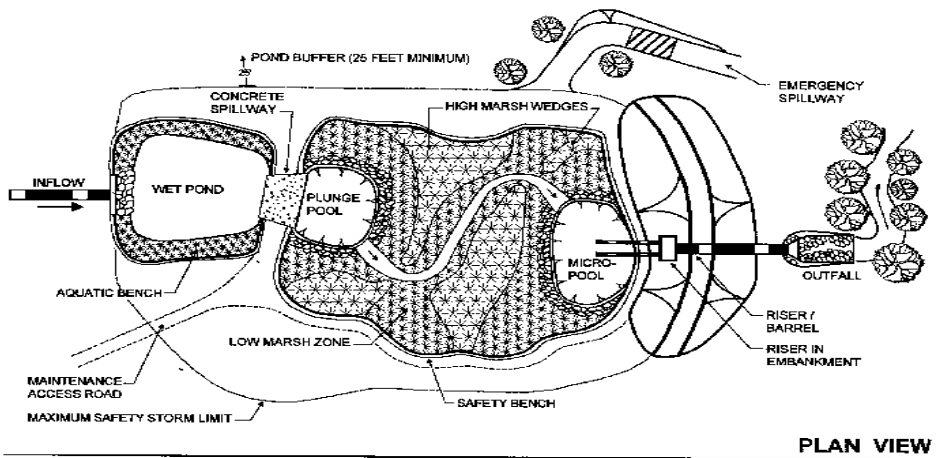
Silt fence: A silt fence is a sediment control structure made of geotextile fabric that restricts the movement of disturbed soil. It is designed to slow the flow of water, but not stop it. To be effective, it needs to be placed on the contour above the area being protected, anchored properly with both ends brought up slope. There needs to be sufficient room behind the silt fence to pond the sediment-laden water.

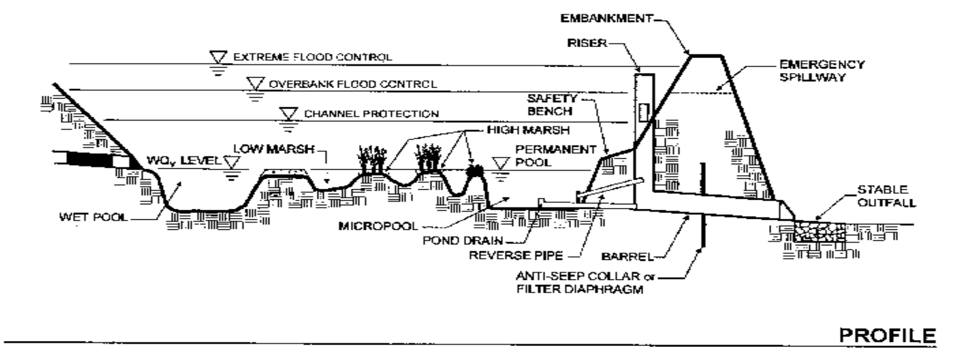


Source: Ohio Department of Natural Resources, 1996

Construction road stabilization: This technique is used in order to temporarily stabilize a roadway for a site by placement of a gravel road base. Construction road stabilization should be applied on roadways used daily by construction traffic or in parking areas susceptible to erosion due to traffic. Application of aggregates over a geotextile base, serves as a valuable management practice because it will contain waste, minimize disturbed areas, stabilize disturbed areas, protect slopes/channels, prevent erosion of the site perimeter, and prevent internal erosion.

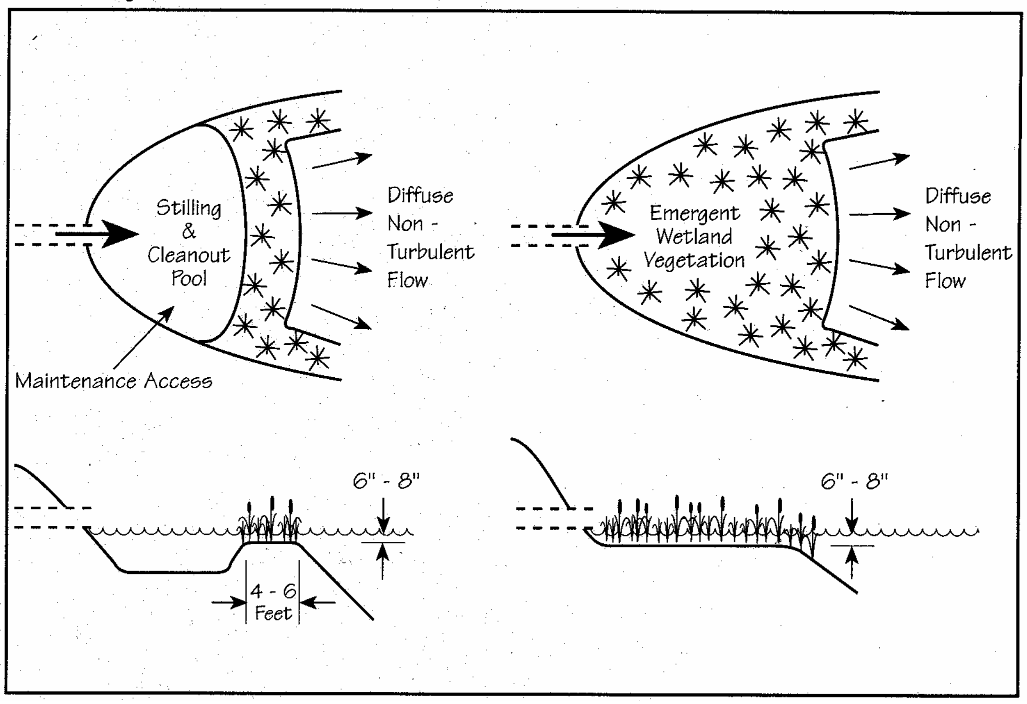
Post Construction BMPs:





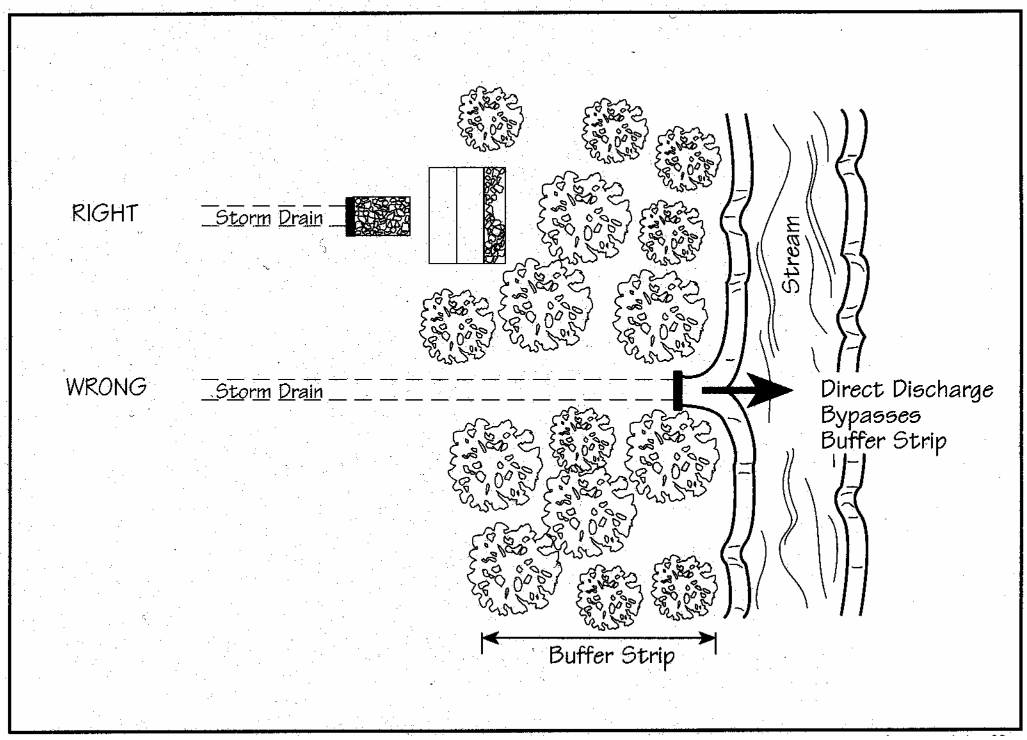
Water Quality Pond: Water quality ponds are designed to treat runoff and improve water quality. Specific design features of water quality ponds remove pollutants either by settling, altering, and biological uptake. Design features may include: long detention times, permanent pools, settling bays where water enters the pond, long flow lengths, shallow wetland environments, aquatic plants, optimum depth, and shaded areas to regulate water temperature. Ponds constructed with these design features also serve to reduce pond maintenance, improve esthetics, and provide wildlife habitat.

Forebay:



Source: Ohio Department of Natural Resources, 1996

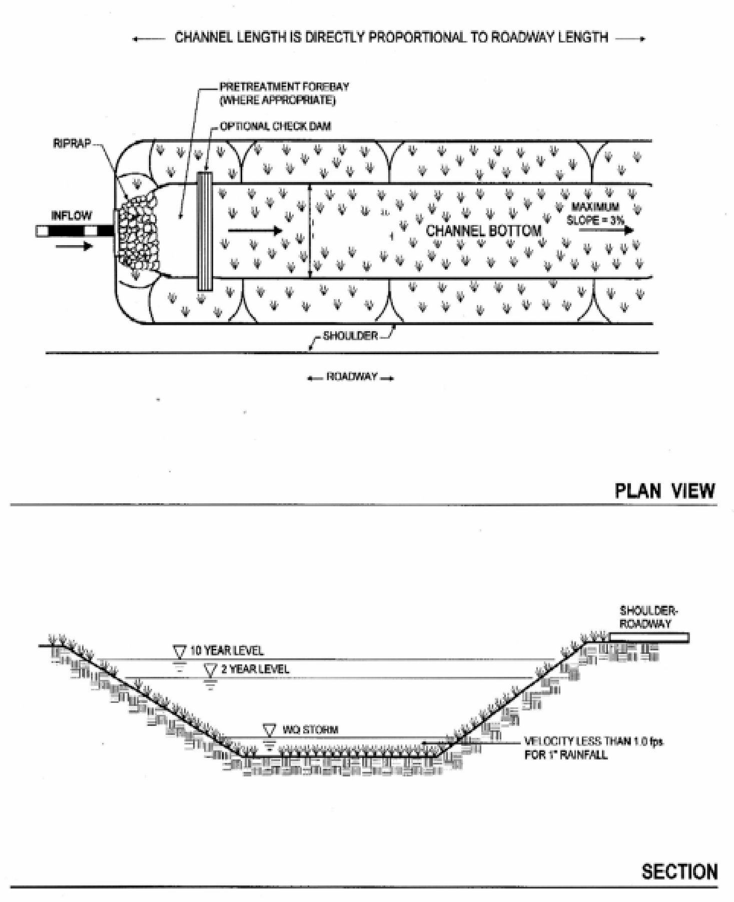
Forebay: At the inlet to a pond, a settling pool called a forebay can be used to store water before it moves into the pond. The forebay is separated from the rest of the pool by a submerged dyke planted with emergent wetland vegetation. The primary purpose of the forebay is not only to improve the settling efficiency of a pond but also reduce maintenance by promoting settling in a confined, easily accessible location.



Source: Ohio Department of Natural Resources, 1996

Level Spreader: A level spreader is a weir used to stop the formation of gullies by converting concentrated flow to sheet flow where pipes or channels discharge to floodplain areas. The top of the level spreader is usually made of rock and constructed at the same elevation as the surrounding ground. Level spreaders serve to improve storm water management in the following ways: increasing infiltration and groundwater recharge, provide water quality treatment of the water flowing from a storm drain system by ensuring sheet flow through a buffer strip or riparian corridor, minimizing disturbance of the riparian corridor and the stream channel, reducing the length of the storm drain or channel, preserving of the natural vegetation, and terminating a storm drain or channel where there is no accessible receiving channel.

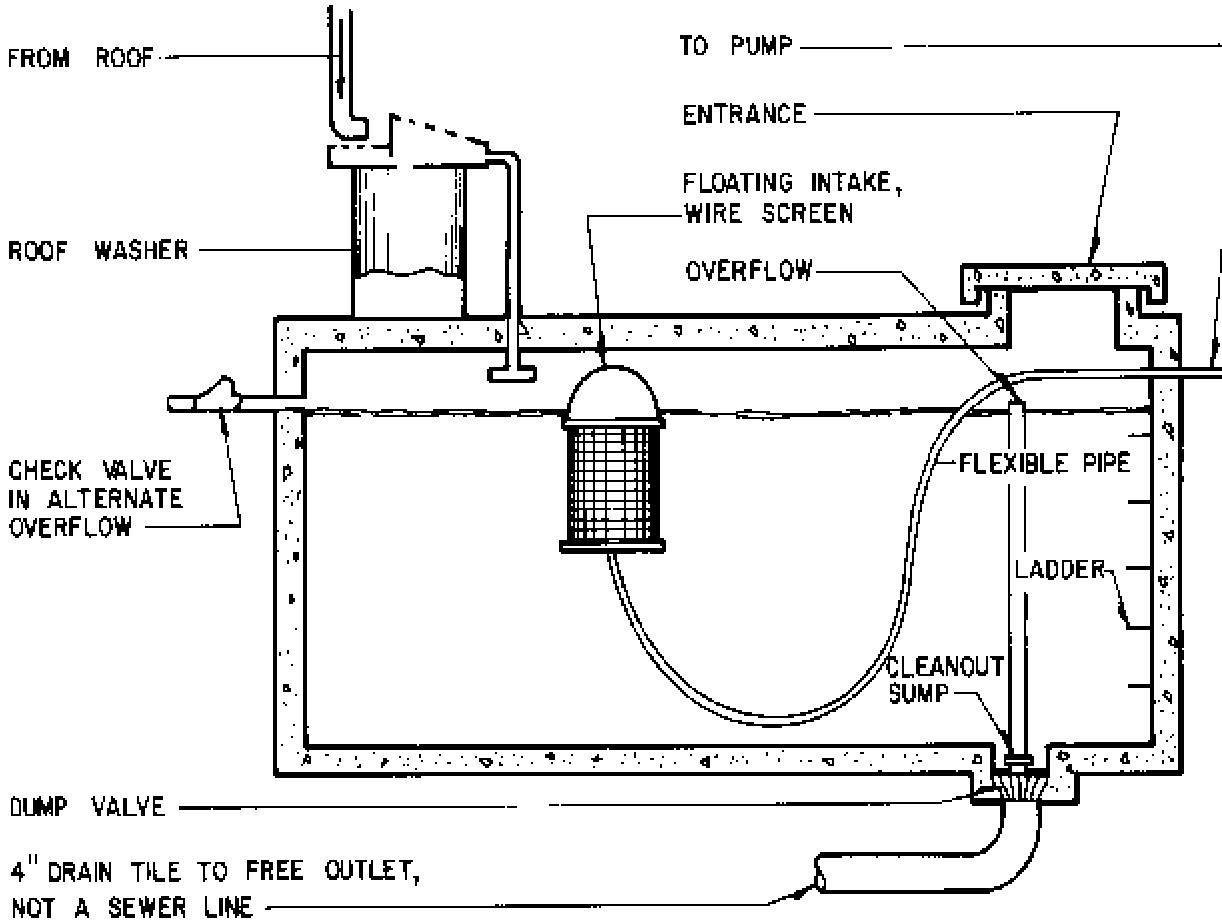
Grassed swales can be used along roadsides and parking lots to collect and treat storm water runoff



Vegetated swale: Vegetated swales (gully or pooling areas) may be used in combination with forebays and level spreaders to help promote infiltration and reduce erosion. Vegetated swales serve to protect against flooding and erosion as the vegetation slows the water flow and filter sediments and contaminants prior to entering a stream or other water body. Adding a sinuous or meandering pattern to the swale helps to further reduce flow velocities and promote filtration.

Grassed filter strips protect water quality by filtering pollutants before they reach the water (Source: USDA, 1997)

Grass filter strip: Grass filter strips are applied as close as possible to the source of runoff. Grass filter strips can be implemented in order to separate impervious surface from storm drains to provide filtration of runoff before it enters a storm drain. Filter strips work best on shallow slopes and may intercept runoff as sheet flow. More elaborate designs may employ a level spreader to dissipate concentrated flows.



Source: University of Florida Cooperative Extension Service

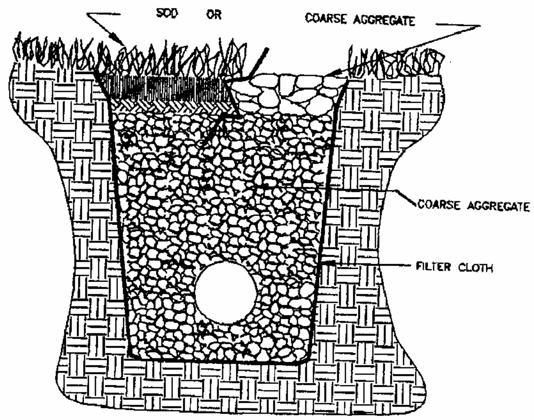
Roof drain cistern: A cistern is a tank or storage area (generally underground) used for storing rain water collected from a roof or other catchment area. It can be used to preserve storm water and as a supplement for irrigation or other uses. If using storm water cisterns as a drinking water supply, additional considerations are needed. For instance, cisterns should be located near the catchment area and underground storage locations should be located where the surrounding area can be graded and sloped away from the cistern to prevent possible contamination from surface water. Additionally, water collected from a roof will vary in quality depending on type of roofing material. Galvanized steel, aluminum and shingles are the most suitable roofing materials for catchments. Sand, charcoal and gravel combination filters may also be used for filtering water before it enters a cistern. However, cistern water should always be chlorinated for domestic use.

Source: NEMO website –
http://nemo.uconn.edu/reducing_runoff/driveways.htm

Shared driveway: Through using a shared driveway, the amount of impervious surface on a lot development is reduced. Shared parking in mixed use areas and structured parking are also green parking techniques that can further reduce the conversion of land to impervious cover. For example, a commercial area could optimize a shared parking arrangement by using the same parking lot for an office space that experiences peak parking demand during the weekday with a church that experiences parking demands primarily during the weekends and evenings. In a residential area, homeowners could share their driveway with neighbors. Costs may dictate the usage of structure parking, but building upwards or downwards can help minimize surface parking.

Storm Water Best Management Practices Specific to Commercial Development Sites

FIGURE 28-3: SURFACE INLETS



NATURAL INLET

Source: http//www.usace.army.mil/inet/usace-docs/
eng-pamphlets/ep1110-1-16/bmp-28.pdf

Perforated storm water conduit: A perforated conduit installed beneath the ground and surrounded by a filter composed of soil, suitable aggregate, and/or filter fabric to filter and remove pollutants from groundwater and/or surface waters. These systems serve one or more of the following purposes:

1. To filter a portion (normally 0.5 to 1-inch) of the storm water runoff contained in retention facilities prior to discharge to surface waters or other receiving waters of the state.
2. To alter the soil environment in treatment areas when not suitable for desired vegetation; usually by regulating the period of inundation, the water table elevation, and/or the inflow of shallow groundwater.
3. To improve the infiltration and percolation characteristics of the soil in storm water management facilities when permeability is restricted due to soil texture or high water table conditions.

Types of storm water conduits include underdrains and filter systems, which are very similar in design. An underdrain would be best in the bottom and along the banks of a retention basin, in the bottom of a grassed waterway, or under a site used for overland flow or landspreading of storm water. A filtration system is usually most effective in the bottom or along the banks of retention basins above the water table.

A worker inserts a catch basin insert for oil and grease, trash, debris, and sediment removal from storm water as it enters the storm drainage system (Source: AbTech Industries, 2001)

Sediment trapping catch basin: Catch basins, which function as an entrance chamber to a storm sewer, often have a low area called a sump. This area is intended to capture sediments, thereby preventing sediments from clogging storm sewers and washing into streams and rivers. In addition to retaining sediments, the catch basins will hold oxygen demanding leaf litter and woody debris. In order to maximize the benefit of the basins with regard to water quality, the sump should be cleaned out when it is 40-60% full or once a month, whichever comes first. At beyond 60% full, a strong flow of storm water through the catch basin could wash the sediments and debris into the storm sewers and to the nearby waterway.

A green parking lot at the Orange Bowl in Miami, Florida (Source: Invisible Structures, no date)

Reduced impervious surface - green parking: There are several "green parking" techniques, which when applied together, reduce the total impervious cover of a parking lot. From a storm water perspective, as green parking techniques serve to dramatically reduce impervious cover, these methods simultaneously reduce the amount of storm water runoff. Green parking lot techniques include setting maximums for the number of parking lots created, minimizing the dimensions of parking lot spaces, utilizing alternative pavers in overflow parking areas, using bioretention areas to treat storm water, encouraging shared parking and providing economic incentives for structured parking.

- Green parking BMPs:

    - Paving blocks: Paving blocks are cement or plastic grids with gaps between them. Through using paving blocks, the surface becomes more rigid. Gravel or grass planted inside the holes allows for infiltration. For certain soil types, a gravel layer can be added underneath to prevent settling and allow further infiltration.
    - Other alternative surfaces: Gravel, cobbles, wood, and mulch also allow varying degrees of infiltration. A loose configuration of brick and natural stone allow for some infiltration through the gaps. Gravel and cobbles can be used as driveway material, while wood and mulch can be used to provide walking trails.

One type of alternative paver consists of a concrete lattice structure for support with grass growing in the void spaces (Source: Lo Gioco Landscaping, Inc., no date)

- Porous pavement: Porous pavement temporarily stores surface runoff before infiltrating into the subsoil. It is a permeable pavement surface with an underlying stone reservoir. The porous surface replaces traditional pavement, allowing parking lot runoff to infiltrate directly into the soil and receive water quality treatment. Porous pavement options, include porous asphalt, pervious concrete, and grass pavers. Porous asphalt and pervious concrete appear the same as traditional pavement from the surface, but are manufactured without "fine" materials, and incorporate void spaces to allow infiltration. Grass pavers are concrete interlocking blocks or synthetic fibrous grid systems with open areas designed to allow grass to grow within the void areas. Although, other alternative paving surfaces can help reduce the runoff from pavement, they do not incorporate the stone trench for temporary storage below the pavement.

A porous pavement parking lot (Source: Invisible Structures, no date)

- Enlarged vegetated parking lot islands: Vegetated islands are designed to allow infiltration so that all the rain water falling in the parking lot area does not discharge directly into a stream or water body. Vegetated islands further improve water quality as larger trees help to regulate the temperature of storm water that is discharged into a natural water way.

Bioretention areas can be used in parking areas to collect and treat storm water (Source: University of Maryland, 2000)

Storm Water Best Management Practices Specific to Residential Development Sites

Rather than having a fully paved cul-de-sac bulb, site designers can incorporate pervious circles with vegetation that reduce the site's overall impervious area

Alternative turnaround: Alternative turnarounds are designs for end-of-street vehicle turnaround that replace cul-de-sacs and reduce the amount of impervious cover created in residential neighborhoods. Many cul-de-sacs can have a radius of more than 40 feet, which translates into a huge bulb of impervious cover, increasing the amount of storm water runoff. For this reason, cul-de-sac size reduction through the use of alternative turnarounds can reduce the amount of impervious cover created at a site. Another approach could be to eliminate the turnarounds all together. Some alternatives to the traditional 40 foot cul-de-sac include reducing the radius to 30 feet, or implementation of hammerheads, loop roads, or pervious islands in the middle.

Source: http://www.raingardens.org/

Rain garden: A rain garden is an attractive native plant garden with a special purpose; to reduce the amount of storm water entering our waters. Rain gardens are constructed as a place to direct storm water from your roof, and are landscaped with beautiful native plant species. By creating a rain garden on your property, you can help reduce the amount of storm water that enters local streams, rivers and lakes. You can use rain the way nature intended, instead of throwing this resource away. A rain garden is a natural way to help solve our storm water pollution problems.

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Section V

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Website Links for Topics Related to Storm Water Management and Development

http://cfpub.epa.gov/npdes/	USEPA – NPDES (National Pollutant Discharge Elimination System) website – click on "storm water" in menu to go to the Storm Water Page for information on Phase II regulations
http://cfpub.epa.gov/npdes/stormwater/swfinal.cfm?program_id=6	USEPA Phase II Storm Water Regulation Fact Sheets
http://www.state.nv.us/cnr/ndwp/dict-1/waterwds.htm	Excellent on-line dictionary of terms related to water
http://www.bmpdatabase.org/	National Storm Water Best Management Practices Database
http://www.epa.gov/npdes/menuofbmps/pub_ed.htm	USEPA Information on Best Management Practices
http://www.epa.gov/ost/stormwater/	USEPA Report on Urban Storm Water Practices
http://www.epa.gov/owow/nps/bestnpsdocs.html	USEPA – List of Best Nonpoint Source Pollution Documents
http://www.epa.gov/owow/nps/urban.pdf	USEPA Document – Techniques for Tracking, Evaluating and Reporting the Implementation of Nonpoint Source Control Measures – Urban
http://www.stormwatercenter.net/	Center for Watershed Protection – information on stormwater issues. Also location for downloading articles from "The Practice of Watershed Protection" by Thomas Schueler and Heather Holland
http://www.nrdc.org/water/pollution/storm/stoinx.asp	Natural Resources Defense Council website on storm water and pollution
http://www.stormwater-resources.com/	Website for information on stormwater references, publications, conferences and other related topics
http://www.cwp.org/smartsites.pdf	*Redevelopment Roundtable: Consensus Agreement* Smart Site Practices for Redevelopment and Infill Projects
http://nemo.uconn.edu/	Nonpoint Education for Municipal Officials website – contains information and publication useful to planners and municipal staff

Urban Best Management Practice (BMP) Resources

Redevelopment Roundtable: Consensus Agreement Smart Site Practices for Redevelopment and Infill Projects, October 2001, Center for Watershed Protection (also found at ***http://www.cwp.org/smartsites.pdf***)

Provides eleven (11) site practices that can be used to mitigate stormwater impacts in a highly urbanized area. Considers development of brownfields (old industrial sites), reducing impervious surface cover, preservation of naturally vegetated areas, long-term management and maintenance implications, rooftop runoff management, parking design/runoff, minimizing stormwater runoff and maximizing vegetated areas, techniques to avoid contact of pollutants with surface runoff, streetscape design to address runoff, designing areas (e.g. courtyards) to store, filter and treat rainfall and promotion of maximizing transportation choices.

USEPA Handbook: Urban Runoff Pollution Prevention and Control Planning EPA/625/R-93/004, Sept. 1993

This document describes runoff control measures (best management practices - BMPs) that are applicable in the urban setting. Table 7-1, below, identifies runoff control measures that are discussed in detail in the text. Screening for the appropriate BMP in a given situation is dependent on several factors including 1) pollutant removal (appropriate for known pollutants and removal efficiencies), 2) existing government structure (e.g., trying to apply countywide regulations in an area of the country where local jurisdictions have home rule and vice versa), 3) legal authority (Can the control be legally implemented and enforced under current regulations?), 4) public or municipal acceptance, and 5) technical feasibility (Can it be implemented given site size, slope, physical features, etc… This can also include financial feasibility – e.g. Can a local community/entity afford to implement an expensive and time-intensive BMP?).

Table 7-1 (modified)
Urban Runoff Pollution Control Best Management Practices (BMPs)

Urban Runoff Controls

Regulatory Controls
Land use regulations
Comprehensive runoff control regulations
Land acquisition (easements,

Source Controls
Cross-connection identification and removal
Proper construction activities
Street sweeping
Catch basin cleaning
Industrial/commercial runoff control
Solid waste management
Animal waste removal
Toxic and hazardous pollution prevention
Reduced fertilizer, pesticide and herbicide use
Reduced roadway sanding and salting

Detention Facilities
Extended detention dry ponds
Wet ponds
Constructed wetlands

Infiltration Facilities
Infiltration basins
Infiltration trenches/dry wells
Porous pavement

Vegetative Practices
Grasses swales
Filter strips

Filtration Practices
Filtration basins
Sand filters

Other
Water quality inlets

Section VI

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THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

AEX–442

Food, Agricultural and Biological Engineering, 590 Woody Hayes Dr., Columbus, OH 43210

Stormwater and Your Community

What is Stormwater Runoff?

When water falls to earth as rain or snow most of it seeps into the ground. However, if the ground is saturated, frozen, or covered with impervious surfaces, precipitation flows over the land, creating stormwater runoff. It occurs everywhere and includes flows from storm drains and natural drainage courses serving industrial, commercial, residential, undeveloped, recreational, and agricultural lands. It can cause flooding, erosion, and pollution problems (Rouge River, 1995).

What is Stormwater Management?

Stormwater management is the process of controlling and processing runoff so it does not harm the environment or human health. Fundamental goals of stormwater management are to mimic the way runoff left the site before development and to prevent water pollution (ODNR, 1996).

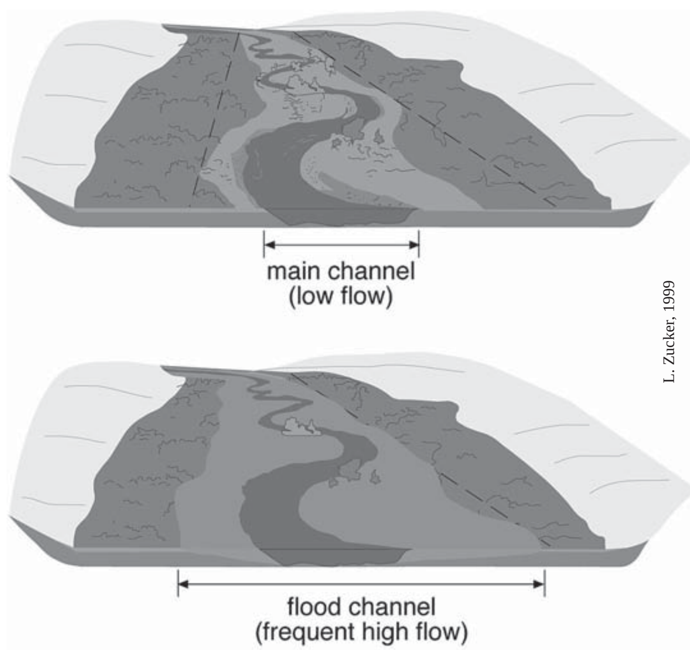
Hydrologic Differences Between Soil and Impervious Cover

Under natural conditions soil and vegetation absorb rain and make it part of the living ecosystem. Water is suspended by organic matter and soil pores, so it's available to plant roots. Microorganisms break down pollutants and convert them into nutrients for the living system. Soil storage turns intermittent pulses of rainfall into a perennial supply of moisture. Since most rainstorms are not large enough to fully saturate the soil, only a small percentage of annual rainwater flows over the surface as runoff. What does become runoff travels slowly, allowing time for suspended particles to settle out. Water percolating deep into soil becomes a stable supply of groundwater, and runoff is naturally filtered of impurities before it reaches creeks, streams, rivers, and bays (Ferguson, 1998).

In contrast, the impervious surfaces associated with urbanization prevent water from infiltrating into the soil. Small rainstorms generate stormwater runoff, which collects urban pollutants and concentrates them into narrow channels or pipes. This rapid concentration of water flow affects the hydrologic cycle in four ways: it increases flood potential, decreases the stability of channels, increases the concentration of pollutants, and reduces ground water levels. (Richman, 1999). The underlying cause of these problems is the loss of the water-retaining function of soil in the urban landscape. Water that may have lingered for a few hours, days, or weeks now flows rapidly across the land surface and arrives at the stream channel in short concentrated bursts (Booth, 1999).

Who Manages Stormwater?

A municipal separate storm sewer system (also known as an MS4) is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains); (USEPA, 1999). This system can be owned or operated by a public entity such as a city, state, town, county, district, or association. This includes special districts under State law such as sewer districts, flood control districts, or drainage districts. It is not a part of a combined sewer and not a publicly



Floodplain areas store water: Development in the floodplain and rigid channel controls are practices that often cause more damaging flood losses. Floodplains are natural detention areas for storm water.

owned treatment work (e.g., a municipal wastewater treatment plant). Storm water management is funded in some municipalities with storm water utility fees.

Stormwater Pollutants

Stormwater runoff has two major adverse impacts. One is related to quantity. Uncontrolled stormwater runoff entering sewers, lakes, rivers, and streams may cause flooding. Second, stormwater runoff often carries pollutants that may severely impact water quality. These discharges can result in fish kills, the destruction of spawning habitats, loss in aesthetic value, and contamination of drinking water supplies and recreational waterways that can threaten public health (USEPA, 1999).

In urbanized areas, a number of surfaces collect pollutants from a variety of sources including air deposition and car exhaust which settle on surfaces such as city streets, driveways, parking lots, and lawns. These pollutants remain until a storm washes them into a nearby storm drain. Automobiles are one of the leading sources of pollution in urban areas. Streets are also major pollution generators because of the large area they cover and the number of cars that use them. Typical pollutants from developed areas include bacteria, pesticides, fertilizers, oils, salt, litter, and sediment. Runoff from some non-vegetated areas, such as construction sites, can carry high sediment loads (Ferguson, 1998).

Traditional Approaches to Stormwater Management

Traditionally, most communities have managed for stormwater quantity rather than water quality. The goal has been to drain water from developed sites as rapidly as possible through the use of gutters, downspouts, pipes, curbs, catch basins, and culverts to eliminate on-site flooding and standing water. Some communities require developers to install detention ponds to temporarily store a portion of the excess runoff, then gradually release it after the peak runoff has occurred. Some hydrologists are concerned that mandating detention ponds on each site, while controlling runoff in the immediate vicinity, may work to collectively increase peak flows in the watershed, resulting in downstream flooding. Experts caution about reliance on one management practice to solve all drainage issues (University of Connecticut, 1995).

The Importance of Watershed Management Plans

Stormwater management begins with an understanding that every piece of land is part of a watershed. A watershed is all the land for which all drainage flows to a common outlet. Comprehensive land use planning and sound site design are essential tools for effective stormwater management. Water resource experts also strongly recommend that communities develop watershed management plans so that management practices can be coordinated by location, size, and function. Comprehensive watershed management plans can include data from field inspections and inventories of existing drainage structures, mapping of watercourses, analysis of runoff rates and allowable capacities, and identification of existing and potential problem areas.

In addition to hydraulic and quantity impacts, watershed management plans should also address water quality issues. Things to include in the plan are: priority water resources to be protected; known sources of contamination and existing pollutant levels; particular contaminants of concern; water quality goals; and overall watershed-level protection measures (such as the use of buffer zones along waterways).

Stormwater management should combine efforts to minimize impervious surfaces with efforts to maximize infiltration of precipitation into the ground. However, there are some areas where infiltration should be avoided, for example: areas with steep unstable slopes; impermeable soils; areas close to water supply wells; areas close to septic systems; areas close to sensitive structural foundations; and contaminated sites that would leach with added flow. Untreated stormwater should not be allowed to discharge directly into surface or subsurface waters.

Site-specific runoff control measures should be based on their location within the watershed. Effective stormwater management will strive to maintain the natural patterns of runoff within the watershed and minimize the extent to which storm drains and constructed ditches replace natural drainage ways. For example, runoff from the lower portions of the watershed should be allowed to pass downstream without delay (as long as the downstream floodway is capable of handling these flows), while runoff from the central and headwater sections of the watershed should be slowed or held back using natural features such as wetlands and floodplains to minimize peak flow rates.

Principles to Strive for in Stormwater Management

These principles might be summarized as “The Four Cs” of stormwater management: control, collection, conveyance, and cleansing. Measures do not fall neatly into one category in most cases. For instance, measures that control runoff, such as grassed swales may convey and clean runoff as well.

These four principles provide a helpful framework for looking at stormwater plans:

Control. Control measures can be broken down into two categories: source control and runoff control. Source control measures focus on pollution prevention. Their objective is to avoid or limit the generation of pollutants. Typical source control measures include proper containment measures, spill prevention and cleanup, waste reduction, public education, illicit connection control, and reduced use of fertilizers and pesticides.

Runoff control measures focus on minimizing runoff from new developments, and siting infrastructure to discourage development in environmentally sensitive areas. These controls are cost-effective if implemented in the site-planning phase of new development projects. Examples of these controls at the municipal planning level include zoning ordinances, subdivision regulations, buffers, and setback requirements. Runoff control measures also include techniques for slowing down runoff. These measures include limiting impervious surfaces, directing flow over grass swales or other vegetated areas, storing runoff in ponds, and installing infiltration systems. An important consideration with these systems is to determine if they will function and who will manage them when installed. All collection systems require regular monitoring and maintenance to ensure their continued effectiveness.

Collection. Capture and storage of runoff for more timely release is a vital component of most stormwater management systems. Retention basins are areas designed to hold the stormwater permanently until it infiltrates into the ground. Detention basins are meant to slow and hold stormwater before releasing it. When runoff is collected in vegetated storage areas such as retention and detention basins, adverse impacts on water resources can be greatly reduced. For sites where total capture is infeasible, studies suggest that collecting the "first flush," the (first 0.5 to 1.2 inches of rainfall) can capture a high percentage of contaminants.

Conveyance. Conveyance systems are used to drain and direct the flow of runoff generated on a site. This is often done with catch basins feeding into storm sewers. More natural systems, using vegetated depressions and swales which look and function much like the natural drainage system, should be used whenever possible. Existing systems can be adapted to reduce runoff; for example, perforated pipes can be used to promote infiltration.

Cleansing. Control, conveyance, and collection of runoff mean little without provisions for cleansing. Cleansing is commonly accomplished through techniques that promote filtration and settling of pollutants and their natural processing by vegetation and soil. Filtering devices include engineered structures like sediment basins and porous pavement, but also include natural systems like stream buffers and vegetated filter strips. Depending on their design, many collection systems like ponds and constructed wetlands also serve to clean water. Infiltration of stormwater into the ground, which allows pollutants to be filtered by natural biological and chemical processes in the soil, should be encouraged whenever soil type and groundwater systems can support it.

Stormwater Management in Ohio

Standard practices for stormwater management for Ohio can be found in *Rainwater and Land Development: Ohio's Standards for Stormwater Management Land Development and Urban Stream Protection* (ODNR, 1996). This publication offers a source of general standards that can be implemented as land is being developed. In Ohio, municipalities, townships, and counties all have authority to regulate stormwater. Ohio EPA administers the state regulations requiring stormwater permits for construction sites and the Phase I and Phase II stormwater regulations. The Phase I regulations cover municipal separate storm sewer systems serving a population of 100,000 or greater. Phase II regulations will cover small municipal separate storm sewer systems in urbanized areas not covered under Phase I regulations. (For more information see USEPA Storm Water Phase II Proposed Rule Factsheets.) Both sets of regulations require owners and operators of municipal separate storm water systems in urbanized areas and construction sites to implement programs and practices to control polluted stormwater runoff.

Ohio statutes generally delegate land use planning to citizen planning commissions. They are charged with the formation of comprehensive plans, review of subdivisions, recommendations on zoning changes, and review of long-range capital improvement projects. Members of these commissions are appointed by elected officials. The Ohio Revised Code and some municipality charters place one or more elected officials on the city or village planning commission (Meck and Pearlman, 1999).

Summary Planning Guidelines for Stormwater Management

Members of planning and zoning commissions routinely review site plans for new construction to determine compliance of a proposed development with land use regulations. A major consideration of the site plan review should be the proposed development's impact on water resources, particularly from stormwater runoff.

Site-by-site evaluation of stormwater plans can be greatly improved and facilitated by having a set of guidelines clearly stating the key management principles that the commission wants developers to address in the site plan. As part of the site plan review, commissioners may want to require assurances that any stormwater management plan complies with these general guidelines. The detailed engineering formulas and designs used to attain compliance with the guidelines are best handled by referring engineers and developers to commonly accepted manuals. Review of engineering designs should be left to trained staff or consultants experienced in the field of water resources. Below is a suggested list of guidelines for applicants to address when designing a stormwater management plan. Commissions should consider using these when reviewing submitted plans. Municipalities might also consider including these guidelines in their subdivision and zoning regulations, and referencing them in watershed management plans.

Recommendations for Stormwater Systems that Protect Water Quality:

1. Consider the total environmental impact of the proposed system.
2. Consider water quality as well as water quantity.
3. Minimize the amount of impervious area to be created.
4. Be consistent with the local Comprehensive Land Use

Plan and any existing watershed management plan.

5. Coordinate stormwater management practices with erosion control measures and aquifer protection.

6. Minimize disturbance of natural grades and vegetation, and utilize existing topography for natural drainage systems if adequate.

7. Preserve natural vegetated buffers along water bodies and wetlands.

8. Maximize infiltration of cleansed runoff to appropriate soils.

9. Reduce peak flow to minimize soil erosion, stream channel instability, flooding, and habitat destruction.

10. Use wetlands and water bodies to receive or treat runoff only when it is assured that these natural systems will not be overloaded or degraded.

11. Provide a maintenance schedule for management practices, including designation of maintenance responsibilities.

World Wide Web Resources

Stormwater Phase II Proposed Rule Fact Sheet Series. Contact the U.S. EPA Water Resource Center at 202-260-7786 or at: waterpubs@epa.gov or www.epa.gov/owm/sw/phase2/index.htm

A Guide to Developing Local Watershed Action Plans in Ohio. Contact the Ohio EPA Division of Surface Water at 614-644-2856 or Internet: http://chagrin.epa.state.oh.us/watershed/index.html

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IMPACTS OF DEVELOPMENT ON WATERWAYS

Linking Land Use to Water Quality

Key Finding

Standard land development can drastically alter waterways. Increase stormwater runoff associated with development often begins a chain of events that includes flooding, erosion, stream channel alteration and ecological damage. Combined with an increase in man-made pollutants, these changes in waterway form and function result in degraded systems no longer capable of providing good drainage, healthy habitat or natural pollutant processing. Local officials interested in protecting town waters must go beyond standard flood and erosion control practices and address the issue of polluted runoff through a multilevel strategy of planning, site design and stormwater treatment.

> "Polluted runoff is now widely recognized by environmental scientists and regulators as the single largest threat to water quality in the United States."

Disruption of the Water Cycle

When development occurs, the resultant alteration to the land can lead to dramatic changes to the *hydrology*, or the way water is transported and stored. Impervious man-man surfaces (asphalt, concrete, rooftops) and compacted earth associated with development create a barrier to the percolation of rainfall into the soil, increasing surface runoff and decreasing groundwater infiltration (Figure 1). This disruption of the natural water cycle leads to a number of changes, including:

- increased volume and velocity of runoff;
- increased frequency and severity of flooding;
- peak (storm) flows many times greater than in natural basins;
- loss of natural runoff storage capacity in vegetation, wetland and soil;
- reduced groundwater recharge; and
- decreased base flow, the groundwater contribution to stream flow. (This can result in streams becoming intermittent or dry, and also affects water temperature.)

Impacts on Stream Form and Function

Impacts associated with development typically go well beyond flooding. The greater volume and intensity of runoff leads to increased erosion from construction sites, downstream areas and stream banks. Because a stream's shape evolves over time in response to the water and sediment loads that it receives, development-generated runoff and sediment cause significant changes in stream form. To facilitate increased flow, streams in urbanized areas tent to become deeper and straighter than wooded streams, and as they become clogged with eroded sediment, the ecologically important "pool and riffle" pattern of the stream bed is usually destroyed (Figure 2).

These readily apparent physical changes result in less easily discerned damage to the ecological function of the stream. Bank erosion and sever flooding destroy valuable streamside, or riparian, habitat. Loss of tree cover leads to greater water temperature fluctuations, making the water warmer in the summer and colder in the winter. Most importantly, there is substantial loss of aquatic habitat as the varied natural

Hyodrolooogy:
A science dealing with the properties, distribution and circulation of water.

Rioparoioan:
Of or related to or living or located on the bank of a watercourse.

Haboiotat:
The place where a plant or animal species naturally lives and grows.

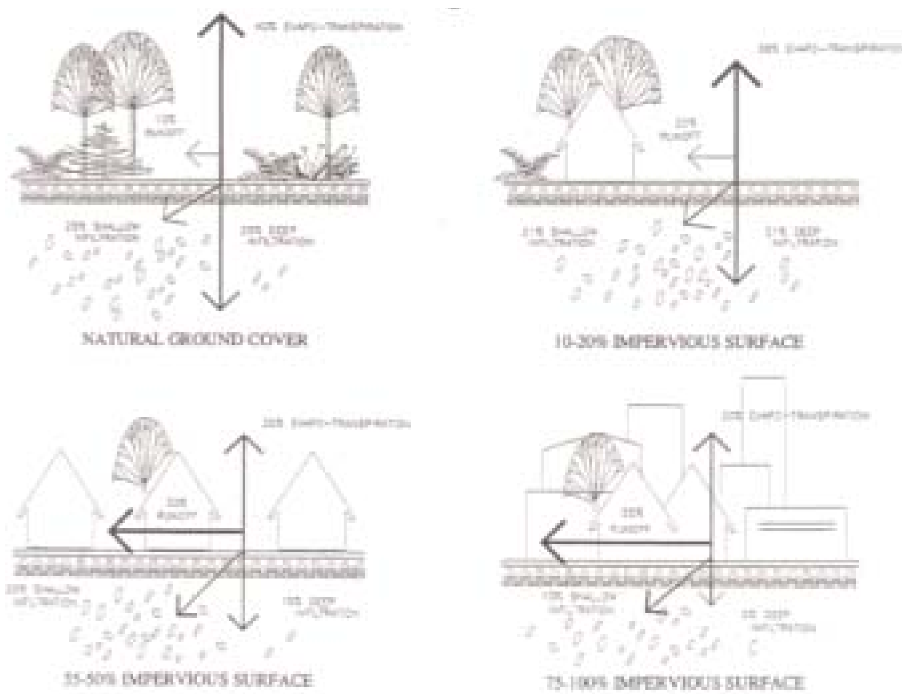

Figure 1. Water cycle changes associated with urbanization (after Toubier and Westmacott, 1981).

streambed of pebbles, rock ledges and deep pools is covered by a uniform blanket of eroded sand and silt.

All of this of course assumes that the streams are left to adjust on their own. However, as urbanization increases, physical alterations like stream diversion, channelization, damming and piping become common. As these disturbances increase, so do the ecological impacts - the endpoint being a biologically sterile stream completely encased in underground concrete pipes. In addition, related habitats like ponds and wetlands may be damages or eliminated by grading and filling activities.

Then There's Water Quality

With development comes more intensive land use and a related increase in the generation of pollutants. Increased runoff serves to transport these pollutants directly into waterways, creating *nonpoint source pollution, or polluted runoff*. Polluted runoff is now widely recognized by environmental scientists and regulators as the single largest threat to water quality in the United States. The major pollutants of concern are pathogens (disease-causing microorganisms), nutrients, toxic contaminants and debris. Sediment is also a major nonpoint source pollutant, both for its effects on aquatic ecology (see above), and because of the fact that many of the other pollutants tend to adhere to eroded soil particles. NEMO Fact Sheet #2 provides more detail on polluted runoff and its effects.

The Total Picture: A System Changed for the Worse

The hydrologic, physical and ecological changes caused by development can have a dramatic impact on the natural function of our waterways.

For more information, contact NEMO at:
University of Connecticut, CES
1066 Saybrook Road
Haddam, CT 06438

Phone:
(860) 345-4511
Fax:
(860) 345-3357

Email:
nemo@canr.uconn.edu

Web Address:
nemo.uconn.edu

Written by:
Chester Arnold

Figure 2. Changes in stream form associated with urbanization.

When increased pollution is added, the combination can be devastating. In fact, many studies are finding a direct relationship between the intensity of development in an area - as indicated by the amount of impervious surfaces - and the degree of degradation of its streams (Figure 3). These studies suggest that aquatic biological systems begin to degrade at impervious levels of 12% to 15%, or at even lower levels for particularly sensitive streams. As the percentage of imperviousness climbs above these levels, degradation tends to increase accordingly.

The end result is a system changed for the worse. Properly working water systems provide drainage, aquatic habitat, and a degree of pollutant removal through natural processing. Let's look at those functions in an urbanized watershed where no remedial action has been taken:

Drainage: Increased runoff leads to flooding. Drainage systems that pipe water off-site often improve that particular locale at the expense of moving flooding (and erosion) problems downstream. Overall systemwide water drainage and storage capacity is impaired.

Habitat: Outright destruction, physical alteration, pollution and wide fluctuations in water conditions (levels, clarity, temperature) all combine to degrade habitat and reduce the diversity and abundance of aquatic riparian organisms. In addition, waterway obstructions like bridge abutment, pipes and dams create barriers to migration.

Pollutant removal: Greater pollutant loads in the urban environment serve to decrease the effectiveness of natural processing. Damage to bank, streams and wetland vegetation further reduces their ability to naturally process pollutants. Finally, the greater volume and irregular, "flashy" pulses of water caused by stormwater runoff impair natural processing by decreasing the time that water is in the system.

What Towns Can Do

Flood and erosion control have long been part of the municipal land use regulatory process, and are usually addressed with engineered systems deigned to pipe drainage off-site as quickly and efficiently as possible. Flooding and erosion, however, are only two of the more easily recognized components of the

For more information, contact NEMO at:
University of Connecticut, CES
1066 Saybrook Road
Haddam, CT 06438

Phone:
(860) 345-4511
Fax:
(860) 345-3357

Email:
nemo@canr.uconn.edu

Web Address:
nemo.uconn.edu

Written by:
Chester Arnold &
Jim Gibbons

Illustrations by:
Dr. John Alexopoulos

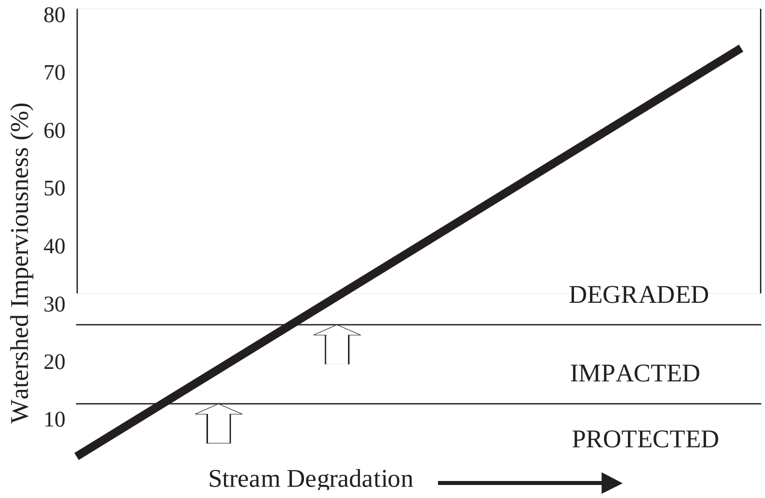

Figure 3. Stylized relationship between watershed imperviousness and receiving stream impacts (adapted from Schueler, 1992).

overall impact of development on waterways. Standard drainage "solutions" address neither the root cause of these symptoms - increased runoff due to the way we develop land - nor the resultant environmental effects.

To begin to truly address the impacts of development, town officials need to look at their waterways as an interconnected system and recognize the fundamental changes that development brings to the water cycle, stream form and function, aquatic ecology, and water quality. Incorporating this understanding into local land use decisions can help to guide appropriate development (see NEMO Fact Sheet #5). There are a number of options that can be employed to reduce the impacts of development on water quantity and quality. Preventing such impacts in the first place is the most effective (and cost effective) approach and should always be emphasized. To this end, town officials should consider a three-tiered strategy of natural resource based planning, appropriate site design and stormwater treatment. NEMO Fact Sheet #4 goes into this strategy in more detail.

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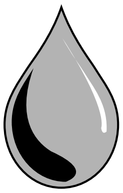
Plan Early For Stormwater In Your New Development



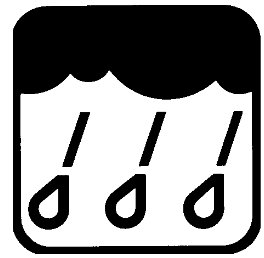
Stormwater Fact Sheet No. 8

This fact sheet is part of a series for local government officials and citizens on stormwater runoff problems and control strategies. The series covers:

1. Stormwater Problems And Impacts
2. Control Principles And Practices
3. Rules And Regulations
4. Local Program Elements And Funding Alternatives
5. Municipal Pollution Prevention Planning
6. Managing Stormwater In Small Communities: How To Get Started
7. Maintaining Wet Detention Ponds
8. Plan Early For Stormwater In Your New Development
9. How Citizens Can Help Control Stormwater Pollution

Land-Of-Sky Regional Council
25 Heritage Drive
Asheville, NC 28806
(704) 251-6622

Introduction

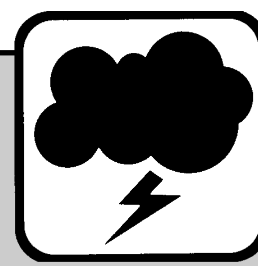


When development occurs, there is usually an increase in impervious surfaces. This causes a significant increase in the volume and rate of stormwater runoff leaving the developed site. Unmanaged stormwater runoff causes downstream flooding, streambank erosion and pollutes our valuable streams, rivers, lakes and coastal waters. The cumulative effects of stormwater runoff on water bodies are evident across the state. Streams draining urbanized areas have fair to poor water quality. Some shellfish waters along the coast have been contaminated and closed due to stormwater runoff and other pollution sources. In response, local, state and federal governments have enacted various regulations to address this problem.

Suggestions for Effective Stormwater Planning

Effective stormwater management requires early consideration and planning for stormwater runoff. Unfortunately, stormwater management is often considered too late in the development planning process. This wastes the developer's valuable time and money and causes unnecessary impacts from unmanaged runoff. Several suggestions for effective stormwater planning are listed below.

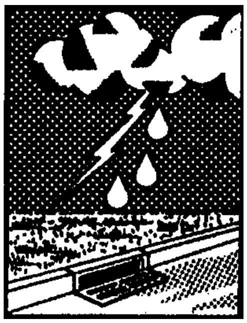
Effective Stormwater Planning



1. **Understand the Impacts & Rules**
2. **Good Site Planning & Design**
3. **Infiltrate What You Can**
4. **Reduce Your Pollution Load**
5. **Structural Controls as a Last Resort**
6. **Have a Good O&M Program**

1. Understand the Impacts and Rules

Be aware of the water quantity and quality impacts of unmanaged stormwater runoff. For example, stormwater runoff is a significant source of water pollution and can destroy the aesthetic value of water bodies and impair their various uses, including fishing, boating, swimming, drinking water supply, shellfishing, etc.



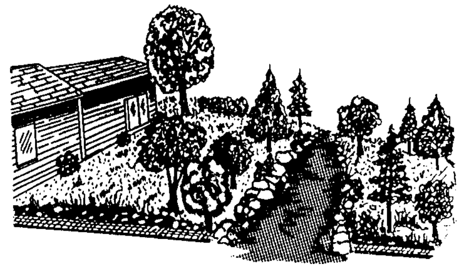
To minimize these impacts, the state and some local governments have adopted stormwater management regulations that apply within certain areas of the state. For example, developments affecting sensitive waterways (e.g., wetlands, water supply watersheds, high quality waters, outstanding resource waters, coastal waters) may be subject to state and/or local stormwater management rules. Know the classification of waters affected by your development and consult state and local officials.

Be aware of all other existing development regulations (e.g., state/local erosion control, Army Corps wetland/dredge and fill, local floodplain/zoning/subdivision/open space/recreation/landscaping rules, state building/plumbing codes, chemical spill containment requirements, etc.) and consider these requirements in planning your development and stormwater management system. Hold early predevelopment meetings with all agency personnel.

Regardless of any regulations, always incorporate good stormwater management practices into the design and construction of your development to minimize any impacts on downstream waters.

2. Good Site Planning and Design

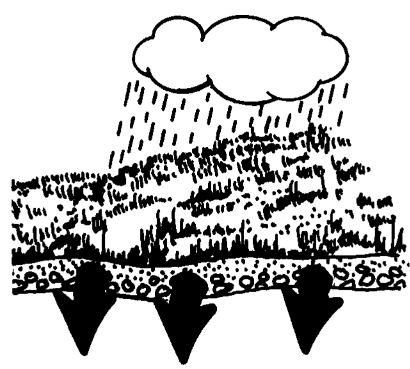
Good site planning and design is the key to effective stormwater management. First, study your site characteristics (e.g., soils, topography, hydrology, etc.) and identify development limitations and opportunities. Plan stormwater practices so they serve as amenities within your development (e.g., greenways with trails). Delineate and protect all environmentally sensitive areas like floodplains, wetlands, etc. Retain vegetative stream buffers and establish development setbacks. Retain or plant tree cover especially along waterways to shade the water and maintain water temperatures.



Minimize the amount of impervious area to the maximum extent possible. Cluster development in suitable areas to minimize roads and retain natural areas. If possible, use angled and smaller parking spaces and narrower road widths to reduce impervious area. Consider using more pervious construction materials in seldom used parking areas.

Eliminate direct discharges of stormwater to waterways. Minimize the use of curb and gutter and maximize the use of vegetated swales. If curb and gutter is necessary, consider curb cuts to divert runoff into stable areas for infiltration. Develop a landscaping plan that uses landscaped areas (e.g., parking islands) as infiltration or detention/retention areas. Instead of grass/turf that requires chemical applications, use trees, shrubs, mulch or other materials that require little or no chemical applications.

3. Infiltrate What You Can

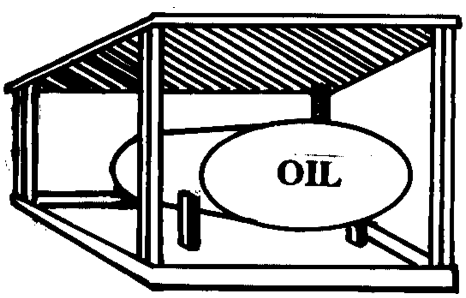


Retain vegetated areas to the maximum extent possible and utilize them fully to infiltrate, detain, filter and evaporate stormwater runoff. Design parking areas, roads, driveways, patios and other impervious areas to drain in a sheet flow into vegetated areas. Discharge downspouts to stable vegetated areas.

4. Reduce Your Pollution Load

There are many source reduction and pollution prevention techniques you can use, especially in the design of commercial and industrial developments.

It begins with soil erosion and sedimentation control on your site. Sediment is the number one pollutant in stormwater runoff. Restrict clearing and grading on highly erodable slopes and minimize the total area disturbed. Install and maintain all necessary practices for stabilizing disturbed areas.



Cover all machinery, storage tanks, waste and raw material piles, dumpsters, recycle bins and other structures that can leach, leak or spill contaminants into stormwater runoff.

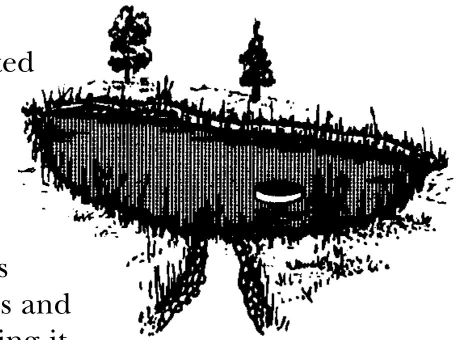
Provide spill containment structures and develop an effective spill response plan. Make sure that floor drains and other outlets exposed to contaminants discharge to the wastewater treatment plant, sanitary sewer or other appropriate facility and not to surface waters.

Stencil storm drain inlets in your development with "Don't Dump – Drains to Stream" warnings.

Educate homeowners/tenants on pollution prevention measures to avoid problems. Develop an environmentally sensitive lawn care maintenance program that minimizes the use of chemicals and uses safe application methods.

5. Structural Controls as a Last Resort

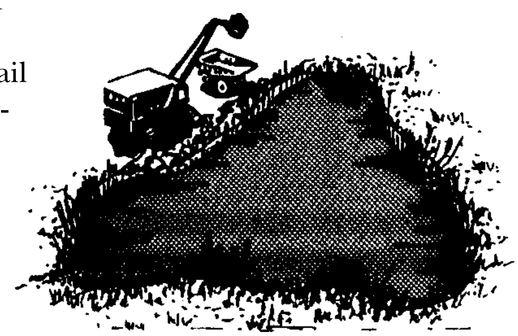
If necessary, use structural controls to reduce peak flows and pollutant loadings. Examples include detention/retention basins, artificial wetlands, bioretention areas, infiltration basins/trenches, sand filters and porous pavement/blocks. If properly sited, designed, constructed and regularly maintained, these devices can be very effective.



Each practice has different advantages and disadvantages, making it suitable or unsuitable for use in different situations (e.g., land requirements, size of drainage area, soils, topography, etc.). An effective stormwater management plan will utilize a number of practices in an integrated system. Early planning for these systems is critical.

6. Have a Good O&M Program

Develop a good operation and maintenance plan/program with clear responsibilities and adequate funding. Frequent inspections should be made of all stormwater practices to ensure they are functioning as designed. Erosion/sedimentation and stormwater management measures will fail without maintenance, which can cause offsite impacts and possible fines.



Make sure there is adequate space and access to detention basins and other practices to allow proper maintenance.

Designate onsite areas for sediment disposal to lower maintenance costs. Inform property buyers/tenants of the location, purpose, and O&M responsibilities of structures (e.g., deed restrictions, lease agreements, etc.).

If necessary, establish an O&M fee to fund necessary maintenance. Encourage all parties to use good housekeeping practices to prevent and manage stormwater runoff impacts.

For More Information

❑ Reference Documents

• Stormwater Management in NC: A Guide For Local Officials, 1994, Land-of-Sky Regional Council - (704) 251-6622.

• Stormwater Management Guidance Manual, 1994, NC Cooperative Extension Service and NC DEHNR - (919) 515-3723.

• Fundamentals of Urban Runoff Management,1994,Terrene Institute - (202) 296-4071.

• Watershed Protection Techniques, Quarterly Bulletin, Center for Watershed Protection - (301) 589-1890.

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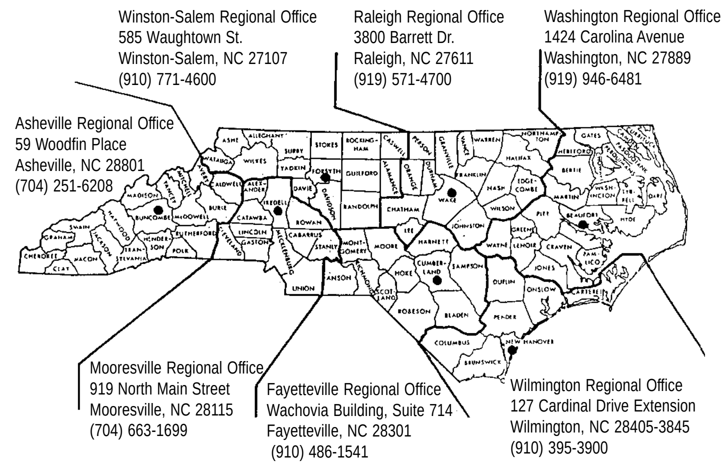

❑ Contacts

• NC DEM Stormwater Management Group - (919) 733-5083, and DEM Regional Offices.

• U.S. Army Corps of Engineers.

• Appropriate Local Government Officials.

LAND-OF-SKY REGIONAL COUNCIL

25 Heritage Drive • Asheville, NC 28806

REVIEWING SITE PLANS FOR STORMWATER MANAGEMENT

Linking Land Use to Water Quality

Considering Stormwater Management in Site Plan Review

Volunteers serving on planning, zoning and wetland commissions routinely review site plans to determine compliance of proposed development with land use regulations. A major consideration of this site plan review should be the proposed development's impact on water resources, particularly from polluted stormwater runoff, or "nonpoint source pollution."

Traditionally, stormwater management has emphasized water quantity, with little concern for water quality. To address both of these factors in a comprehensive manner, each site plan should contain a stormwater management plan that details the impact of proposed land use on water quantity and quality, both on-site and within the watershed.

> "Each site plan should contain a stormwater management plan addressing the impact the proposed land use will have on quantity and quality."

While the detailed engineering is best left to trained professionals, land use commissioners can review plans for compliance with general planning guidelines.

The Need for Stormwater Management in a Watershed Framework

When water falls to earth as rain or snow most of it seeps into the ground. However, if the ground is saturated, frozen or covered with impervious surfaces, excess precipitation flows over the land. Stormwater management is the process of controlling and cleansing excess runoff so it does not harm natural resources or human health.

A major focus of stormwater management should be prevention of nonpoint source water pollution. (See NEMO Project Fact Sheet #2.) It is more cost effective to prevent flooding and water pollution than to correct problems after damage has occurred.

Potential Impact of Development on Water Resources.

Development may disturb land and create impervious surfaces such as roads, rooftops and compacted soil that in turn drastically change natural drainage patterns. During construction, existing grades and vegetation can be damaged, resulting in soil erosion. Runoff from these areas can pollute streams. Development, through increases in impervious surfaces and installation of storm sewers, speeds movement of concentrated pollutants off-site and interferes with water infiltration to the ground. (See NEMO Project Fact Sheet #3.)

Traditional Approaches To Stormwater Management.

Most communities attempt to manage stormwater by emphasizing water quantity rather than water quality. The goal has been to drain water from developed sites as rapidly as possible through the use of gutters, downspouts, pipes, curbs, catch basins and culverts. Some communities require developers to install detention ponds to temporarily store a portion of the excess runoff, then gradually release it after the peak natural runoff has occurred. Many hydrologists are concerned that mandating detention ponds on

For more information, contact NEMO at:
University of Connecticut, CES
1066 Saybrook Road
Haddam, CT 06438

Phone:
(860) 345-4511
Fax:
(860) 345-3357

Email:
nemo@canr.uconn.edu

Web Address:
nemo.uconn.edu

Written by:
Jim Gibbons, Roy Jeffery
& Susan Brant

each site, while controlling runoff in the immediate vicinity, may work to collectively increase peak flows in the watershed, resulting in downstream flooding. Experts caution about reliance on one management practice to solve all drainage issues.

The Importance of Watershed Management Plans.
Stormwater management begins with an understanding that every piece of land is part of a watershed. A watershed is defined as an area in which all drainage flows to a common outlet. Comprehensive land use planning and sound site design are necessary for effective stormwater management. Water resource experts strongly recommend that towns develop watershed management plans, so that management practices on individual sites can be coordinated as to location, size and function. Comprehensive watershed management plans include data from field inspections and inventories of existing drainage structures, mapping of watercourses, analysis of runoff rates and allowable capacities, and identification of existing and potential problem areas.

"Stormwater management begins with an understanding that every piece of land is part of a watershed."

In addition to hydraulic and quantity impact analysis, watershed management plans should also address water quality issues. Things to be identified in the plan should include: priority water resources to be protected; known sources of contamination and existing pollutant levels; particular contaminants of concern; water quality goals; and overall watershed-level protection measures (such as use of buffer zones along waterways).

Within the context of a watershed plan, stormwater management should combine efforts to minimize impervious surfaces with efforts to maximize infiltration of clean runoff into the ground. Untreated stormwater should not be allowed to discharge directly into surface or subsurface waters. Site-specific runoff control measures should be based on their location within the watershed. Effective stormwater management will maintain the natural patterns of runoff within the watershed. For instance, clean runoff from the lower portions of the watershed should be allowed to pass downstream without delay (as long as the downstream floodway is capable of handling these flows), while runoff from the central and upper sections of the watershed should be slowed or held back to prevent increasing peak flow rates.

The Contents of a Stormwater Management Plan

Developers are generally required to submit site plans to help local officials determine whether proposed development complies with municipal land use regulations. Each site plan should contain a stormwater management plan addressing the impact the proposed land use will have on water quantity and quality.

Site-level stormwater management plans are generally composed of maps and a narrative. The maps and associated construction drawings show existing site features and proposed alterations highlighting the location and type of proposed stormwater management system. The narrative consists of a written statement explaining the natural and proposed drainage system, a detailed description of projected runoff quantity and quality and an explanation of why certain management practices were chosen for pollution control. Highlighted should be a detailed description of the relationship of the proposed development to drainage and runoff within the entire watershed (with reference to a watershed management plan should one exist). Provisions for site safety and maintenance of approved management measures should also be included.

For more information, contact NEMO at:
University of Connecticut, CES
1066 Saybrook Road
Haddam, CT 06438

Phone:
(860) 345-4511
Fax:
(860) 345-3357

Email:
nemo@canr.uconn.edu

Web Address:
nemo.uconn.edu

Written by:
Jim Gibbons, Roy Jeffery
& Susan Brant

Principles to Strive for in Stormwater Management

Stormwater management should include measures to control and convey runoff flow, and to collect and cleanse runoff on-site. These principles might be summarized as "**The Four Cs" of stormwater management: control, conveyance, collection**, and **cleansing**. Measures do not fall neatly into one category in most cases; for instance, measures that control runoff, such as swales, may convey and clean runoff as well. These four principles, however, can provide a helpful framework for looking at stormwater plans.

1. Control. Control measures can be broken down into two categories: source control and runoff control. Source control measures focus on pollution prevention. Their objective is to avoid or limit the generation of pollutants. Typical source control measures include erosion control, street and parking lot sweeping, hazardous waste collection, and reduced usage of fertilizers and pesticides. Runoff control measures focus on slowing down runoff, in order to reduce the likelihood of erosion, downstream flooding, and pollutant transport. These measures include limiting impervious surfaces, directing flow over grass swales or other vegetated areas, storing runoff in ponds, and installing infiltration systems.

2. Conveyance. Conveyance systems are used to drain and direct the flow of runoff generated on a site. This is often done with tile pipes feeding into catch basins and storm sewers. More natural systems using vegetated depressions and swales, which look and function much like the natural drainage system, should be used whenever possible. Existing systems can be adapted to reduce runoff; for example, perforated pipes can be used to promote infiltration. Particular attention should be given to system outlets, which commonly become restricted or blocked if poorly designed.

3. Collection. Capture and storage of runoff for more timely release is a vital component of most stormwater management systems. When runoff is collected in a vegetated storage area like a retention or detention pond, the sites' adverse impacts on water resources can be greatly reduced. For sites where total capture is infeasible, studies suggest that collecting the "first flush" of onehalf to one inch of rainfall can capture a high percentage of contaminants. All collection systems require regular monitoring and maintenance to insure their continued effectiveness.

4. Cleansing. Control, conveyance, and collection of runoff mean little without provisions for cleansing. Cleansing is commonly accomplished through techniques that promote filtration and settling of pollutants, and their natural processing by vegetation and soil. Filtering devices include engineered structures like catch basins, sediment basins, and porous pavement, but also include more natural systems like stream buffers and vegetated filter strips. Depending on their design, many collection systems like ponds and wetlands also serve to cleanse water. Infiltration of stormwater into the ground, which allows pollutants to be cleansed by natural biological and chemical processes in the soil and helps to recharge groundwater, should be encouraged wherever soil type and groundwater systems can support it.

Summary Planning Guidelines For Stormwater Management

Site-by-site evaluation of stormwater plans can be greatly improved and facilitated by having a set of guidelines clearly stating the key management principles that the commission wants each applicant to address in a site plan. As part of site plan review, commissioners should require assurances that any stormwater management plan complies with these general guidelines. The detailed engineering formulas and designs used to attain compliance with the guidelines are best handled by referring engineers and developers to commonly accepted manuals. Review of engineering design should be left to trained staff or consultants experienced in the field of water resources.

Below is a suggested list of guidelines that applicants should address when designing a stormwater management plan. Commissions should consider using these when reviewing submitted plans. Municipalities might also consider including these guidelines in their subdivision and zoning regulations, and referencing them in watershed management plans.

The Storm Management System Shall:

1. **Consider the total environmental impact of the proposed system.**
2. **Consider water quality as well as water quantity.**
3. **Be consistent with the local Plan of Development, and any existing watershed management plan.**
4. **Coordinate with erosion control measures and aquifer protection.**
5. **Minimize disturbance of natural grades and vegetation, and utilize existing topography for natural drainage systems.**
6. **Preserve natural vegetated buffers along water resources and wetlands.**
7. **Minimize impervious surfaces and maximize infiltration of cleansed runoff to appropriate soils.**
8. **Direct runoff to minimize off-site volume.**
9. **Reduce peak flow to minimize the likelihood of soil erosion, stream channel instability, flooding and habitat destruction.**
10. **Use wetlands and water bodies to receive or treat runoff only when it is assured that these natural systems will not be overloaded or degraded.**
11. **Provide a maintenance schedule for management practices, including designation of maintenance responsibilities.**

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Phone:
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(860) 345-3357

Email:
nemo@canr.uconn.edu

Web Address:
nemo.uconn.edu

Written by:
Jim Gibbons, Roy Jeffery
& Susan Brant

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College of Agriculture and Natural Resources

THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

AEX–441

Food, Agricultural and Biological Engineering, 590 Woody Hayes Dr., Columbus, OH 43210

Non Point Source Water Pollution

What is Nonpoint Source Pollution?

Nonpoint source pollution is a fancy term for polluted runoff. Water washing over the land, whether from rain, car washing, or the watering of crops or lawns, picks up an array of contaminants including oil and sand from roadways, agricultural chemicals from farmland, and nutrients and toxic materials from urban and suburban areas. This runoff finds its way into our waterways, either directly or through storm drain collection systems. The term nonpoint is used to distinguish this type of pollution from point source pollution, which comes from specific sources such as sewage treatment plants or industrial facilities. Scientific evidence shows that although huge strides have been made in cleaning up major point sources, our precious water resources are still threatened by the effects of polluted runoff. In fact, the Environmental Protection Agency has estimated that this type of pollution is now the single largest cause of the deterioration of out nation's water quality.

Whatever They Call It, Why Should I Care About It?

The effects of polluted runoff are not limited to large lakes or coastal bays. In fact, chances are you don't have to look any farther than your neighborhood stream or duck pond. Water pollution in your town, and perhaps in your own backyard, can result in anything from weed-choked ponds to fish kills to contaminated drinking water.

There's not much chance that you can ignore this problem, even if you want to. Concern over polluted runoff has resulted in an ever-increasing number of state and federal laws enacted over the last five years. At the federal level, a permit program for stormwater discharges from certain municipalities and businesses is now underway. In addition to implementing this federal program, many states have passed laws altering local land use (planning and zoning) processes and building codes to address the problem of polluted runoff. The bottom line is that both polluted runoff and its management are likely to affect you and your community in the near future.

What Causes Polluted Runoff?

You do. We all do. Polluted runoff is the cumulative result of our everyday personal actions and our local land use policies. Here's a brief rundown on the causes and effects of the major types of pollutants carried by runoff.

Pathogens: Pathogens are disease-causing microorganisms, such as bacteria and viruses, that come from the fecal waste of humans and animals. Exposure to pathogens from direct contact or ingestion of water can cause a number of health problems. Because of this, bathing beaches are closed, and boil water alerts are issued when testing reveals significant pathogen levels. Pathogens wash off the land from wild animals, farm animals, and pet waste, and can also enter our waterways from improperly functioning septic tanks, leaky sewer lines, and boat sanitary disposal systems.

Nutrients: Nutrients are compounds that stimulate plant growth, like nitrogen and phosphorous. Under normal conditions, nutrients are beneficial and necessary, but in high concentrations, they can become an environmental threat. Nitrogen contamination of drinking water can cause health problems, including "blue baby" syndrome. Over fertilization of ponds, streams, and lakes by nutrients can lead to massive algal blooms, the decay of which can create odors and rob the waters of life-sustaining dissolved oxygen. Nutrients in polluted runoff can come from agricultural fertilizers, septic systems, home lawn care products, and yard and animal wastes.

Sediment: Sand, dirt, and gravel eroded by runoff usually ends up in stream beds, ponds, or lakes where they can alter stream flow and decrease the availability of healthy aquatic habitat. Poorly protected construction sites, agricultural fields, roadways, and suburban gardens can be major sources of sediment.

Toxic Contaminants: Toxic contaminants are substances that can harm the health of aquatic life and/or human beings. Toxins are created by a wide variety of human practices and products, and include heavy metals, pesticides, and organic compounds like PCBs. Many toxins are very resistant to breakdown and tend to be passed through the food chain to be concentrated in top predators. Fish consumption health advisories are the result of concern over toxins. Oil, grease, and gasoline from roadways and chemicals used in homes, gardens, yards, and on farm crops, are major sources of toxic contaminants.

Debris: Trash is without a doubt the simplest type of pollution to understand. It interferes with enjoyment of our water resources and, in the case of plastic and polystyrene foam, can be a health threat to aquatic organisms. Typically this debris starts as street litter that is carried by runoff into our waterways.

What Can I Do About All This?

First of all, you can begin to clean up your own act. There are many good publications and programs that can help you do simple, but important things like conserving water, disposing of hazardous waste properly, and gardening in an environmentally responsible manner.

Polluted runoff is largely the result of the way we develop, use, and maintain our land. These policies are largely decided at the municipal level, through the actions of local officials.. There are many techniques and regulations that can greatly reduce the effects of polluted runoff, and there are more being developed every day. Other Ohio NEMO fact sheets are devoted to telling you about your options. If you're a local official, learn a little more about polluted runoff and how you can combat it in the course of your everyday decisions. If you're not, ask your local officials, friends, and neighbors what they are doing about polluted runoff.

Acknowledgments to John Rausch and Jay Dorsey, Department of Food, Agricultural, and Environmental Engineering, The Ohio State University, for their review of this fact sheet.

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AEX-443-2000

THE OHIO STATE UNIVERSITY EXTENSION

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Food, Agricultural, and Biological Engineering, 590 Woody Hayes Dr., Columbus, OH 43210

Coping With Polluted Runoff

As the intensity of land development increases, so does the generation of nonpoint source water pollution, or polluted runoff. A good indicator of the intensity of development in a given area is the amount of impervious surface. Studies have shown that the greater the impervious surface coverage in a watershed, the greater the potential degradation of that watershed's water systems. Local officials can do much to protect their water resources by considering the location, extent, drainage, and maintenance of impervious surfaces on the town, watershed, and individual site levels. Natural resource planning, site design, and use of best management practices (BMPs) form an effective three-tiered approach to the problem.

Land development affects both the quantity and the quality of stormwater runoff, which in turn has impacts on watercourses. By enhancing and channeling surface drainage in favor of natural drainage systems, impervious surfaces like asphalt, concrete, and roofing increase the volume and velocity of the runoff, often resulting in flooding, erosion, and permanent alterations in stream form and function. In addition, by blocking the infiltration of water and its associated pollutants into the soil, impervious surfaces interfere with the natural processing of nutrients, sediment, pathogens, and other contaminants, resulting in degradation of surface water quality.

Because of these impacts, a growing body of scientific research has found a direct relationship between the amount of impervious surface in a watershed and the water quality of the watershed's receiving stream. Many studies find that without nonpoint source management of some kind, stream water quality becomes increasingly degraded as impervious levels climb above 15%; in highly sensitive streams, degradation can begin when as little as 8% to 10% of the watershed area has impervious cover.

What Communities Can Do

Pavement is an unavoidable fact of modern life. However, many options are still available to the municipality interested in reducing the water quality impacts of existing or future development. Strategies can be organized into a three-tiered approach, which can be summarized as plan, minimize, and mitigate.

1. Plan Development Based on Your Community's Natural Resources.

Remember that preventing pollution by wise planning is by far the least expensive and most effective way to protect your local waterways. To this end, a working knowledge of your community's natural resources is critical to guide appropriate development. A natural resource inventory is an essential first step. Identifying important natural resources and setting protection priorities provides a framework within which the impacts of proposed or existing development can be evaluated. Formal inclusion of these priorities in local land-use plans and procedures is also important.

Broad resource protection strategies applied at the local or watershed level, such as buffer zone and setback requirements, are increasingly coming into use. With regard to impervious surfaces, local officials should consider a "budget" approach that sets an overall limit for key areas, and above that limit requires increase in pavement on one site to be compensated for by decreases on another site (or some other acceptable method of compensation). This technique might be appropriate, for instance, in a watershed where analyses show a threat to critical water resources from future growth.

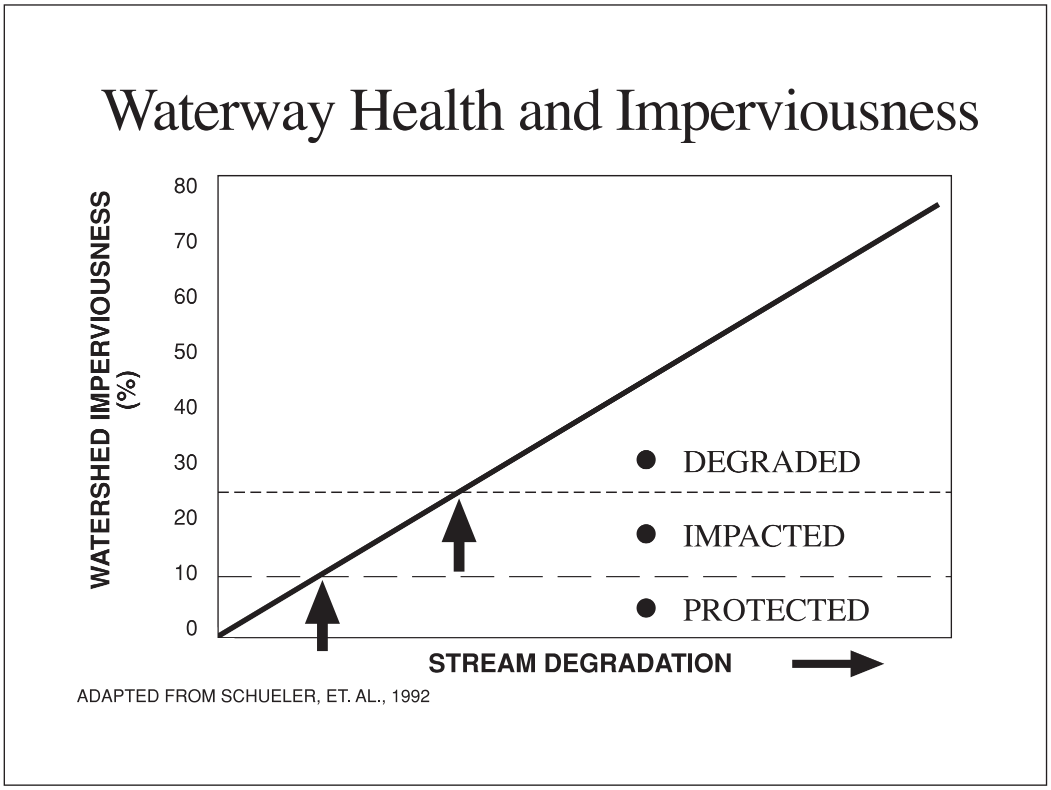
2. Minimize Impacts Through Site Design.

The site planning stage offers the best chance for local officials, designers, and builders to work together to reduce polluted runoff from a site. Evaluate site plans with an eye to minimizing both impervious areas and disruption of natural drainage and vegetation. Cluster development, which reduces the total area of paved surfaces and increases open space, should be considered. Are the proposed sidewalks, roads, and parking lot sizes absolutely necessary, or could they be reduced? Brick, crushed stone, or pervious pavement is often a viable alternative in low traffic areas. Are curbing and piping necessary, or could drainage be directed to vegetated swales? Designs that reduce grading and filling and retain natural features should be encouraged. In addition to protecting waterways, such designs can often be less expensive and more pleasing to the eye.

3. Mitigate Unavoidable Impacts by Using Best Management Practices.

Best management practices (BMPs) include a whole range of methods designed to prevent, reduce, or treat stormwater runoff. Choosing the correct BMPs is often highly site-specific. There are some basic BMP concepts to keep in mind:

Slow that stormwater. This is the basic idea behind both detention basins, which are meant to slow and hold stormwater before releasing it, and retention basins, which are designed to hold the water permanently until it infiltrates into the ground. In both cases, pollutant removal takes place through settling of particles and through chemical and biological interactions in the



Research in several geographic locations has demonstrated a direct correlation to surface water quality and the amount of impervious surface area. Water quality is seriously impacted in watersheds with greater than 10% impervious cover area. It is considered degraded when impervious surface area reaches 25% for any given watershed.

standing water or in the soil. As with any device, these BMPs must be correctly designed in order to work properly. For instance, basins must be large enough to treat runoff generated by the combination of local climate and site configuration.

Avoid direct connections. Break up the "expressway" of polluted runoff by using grass swales, filter strips, or other forms of vegetative BMPs wherever possible in place of curbing and piped drainage. In many cases, these methods are most effective when used in combination with structural BMPs like detention ponds.

Ensure regular maintenance. Most structural BMPs require maintenance to retain peak pollutant-removal efficiency. Maintenance costs are relatively low and include such things as sweeping parking lots, cleaning storm grates, and removing plant material. However, you should anticipate and plan for these costs.

Don't forget the two e's—enforcement and education. It's important to make sure that contractors are following through on agreed-upon designs and methods. Don't underestimate things like storm drain stenciling and hazardous waste disposal days, which can reduce pollution, raise public awareness, and help to engender support for all your town's water protection activities.

Sources

Schueler, T. and John Galli. 1992. Environmental Impacts of Stormwater Ponds. In: *Watershed Restoration Source Book.* Anacostia Restoration Team. Metropolitan Washington Council of Governments. Washington, D.C. 242 pp.

Reviewers

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THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

CL–1000-01

Food, Agricultural and Biological Engineering, 590 Woody Hayes Dr., Columbus, OH 43210

Multi-Functional Landscaping: Putting Your Parking Lot Design Requirements to Work for Water Quality

Martin F. Quigley
Assistant Professor, Urban Landscape Ecology
Horticulture and Crop Sciences

Timothy Lawrence
Program Director, Ohio NEMO
Food, Agricultural and Biological Engineering

Stormwater runoff is now the leading cause of impairment to Ohio's streams and waterways. Agricultural drainage—sediments and chemicals—is a major source of this impairment. However, nonpoint source (NPS) pollution from urban impervious surfaces (i.e., parking lots, roadways, sidewalks, rooftops, etc.) is also a major contributor. Parking lots collect grease, oil, anti-freeze, and other vehicle leakage, heavy metals from brake dust, as well as litter, other debris, and pathogens. All of these pollutants are flushed into waterways by rain and melting snow. In addition, impervious areas hasten the movement of stormwater runoff across the surface, into a series of curbs, gutters, drains, and pipes, increasing flood occurrence and stream bank erosion. State laws, as well as some local ordinances, now mandate that detention areas be constructed to detain excess runoff from large parking lots. These offsite, rock-edged basins are often unattractive, unsafe, and wasteful of valuable property. In addition, federal regulations require most urban communities to reduce the amount of polluted stormwater runoff.

One relatively low cost[1] alternative to separately built, highly engineered, and questionably effective detention ponds is to integrate the absorption of parking lot runoff into landscape islands. Commonly known as "bioretention" areas, these landscaped islands treat stormwater using a combination of microbial soil process, infiltration, evaporation, and appropriate plantings[2]. Instead of the typical landscape islands that are set higher than paved grade (and which often require supplemental irrigation), these "biofiltration" or wetland landscape islands are recessed, and the pavement graded so that surface flow is into, rather than away from these areas. Even in small parking lots where there are no landscape islands, biofiltration of stormwater can be achieved through the diversion of the stormwater runoff to a landscaped area at the perimeter of the lot. In addition to bioretention areas two other options—sand filters, and/or grassed filter strips—may be considered for perimeter applications. The use of subsurface drains (under-drainage) is optional for both the islands and perimeter systems, depending on conditions of the particular site. Subsurface drains may also be designed to deliver water in times of drought.

Along with reduction of surface water flow rates and pollution loading, additional benefits of bioretention areas in parking lots include storage of snow from winter plowing, and groundwater recharge (if tile drainage is not installed, and infiltration is allowed to occur). One caveat is that bioretention islands and perimeter swales may not provide complete "quantity control," or capacity for retention during heavy rainfall. This may require the use of "shunt" pipes to bypass the biofiltration system and discharge the excess stormwater runoff directly into perimeter

[1]The Stormwater Management Fact Sheet: Bioretention (**http://www.stormwatercenter.net/Assorted%20Fact%20Sheets/Tool6_Stormwater_Practices/Filtering%20Practice/Bioretention.htm**) refers to these systems as relatively expensive. However, costly landscaped areas and under-drains are often normally included in parking lot design. Bioretention areas can either eliminate or reduce the size of detention ponds, and combined with the environmental benefit that can be realized, the overall cost is relatively low.

[2]Bitter, Susan D., and J. Keith Bowers. 2000. Bioretention as a Stormwater Treatment Practice. *The Practice of Watershed Protection*: Article 110 548-550.

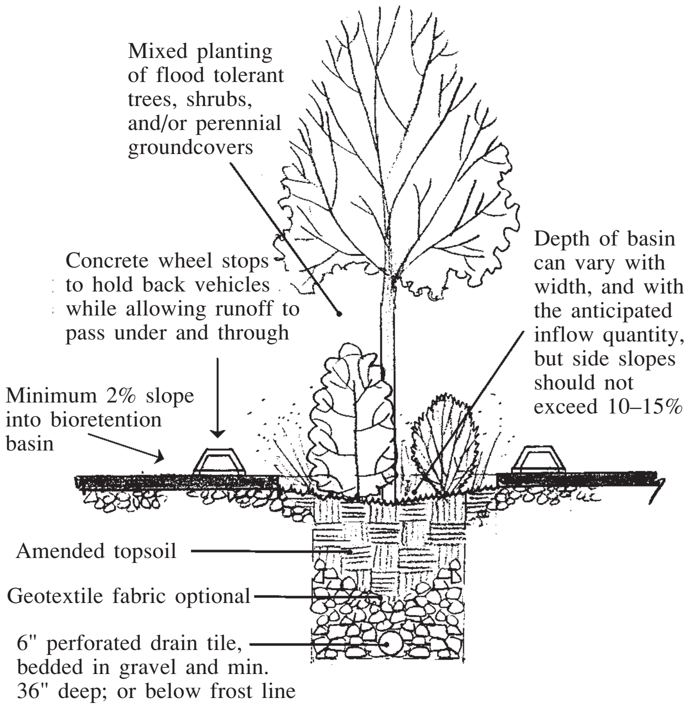

Figure 1. Cross section of a parking lot "wetland island" for bioretention, with an 8-foot width.

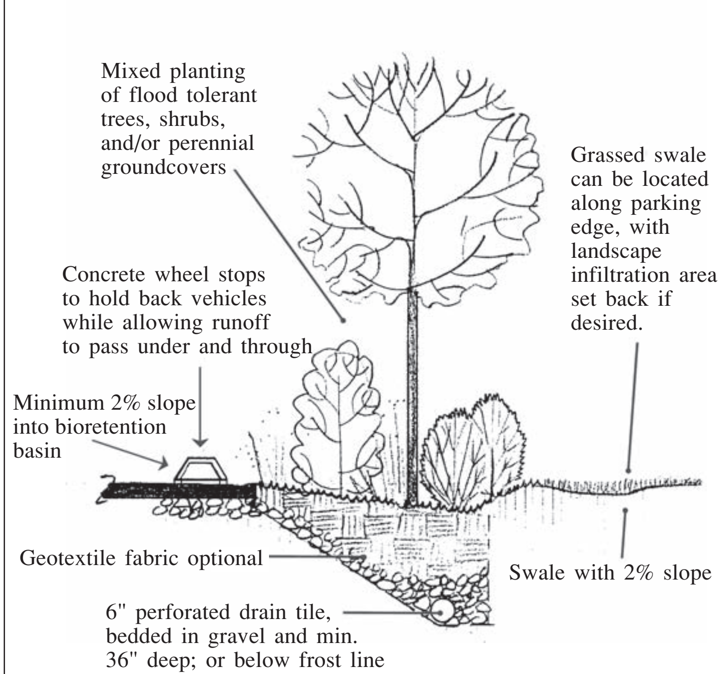

Figure 2. Cross section view of a parking lot edge, with a biofiltration strip and optional subsurface runoff collection.

swales or conventional conveyance systems. Such bypasses may be designed to handle the 5 or 10 year storm event and may require the use of an additional infiltration or detention basin to meet the local discharge requirements.

Drainage can actually be used as a design element. Optimal minimum coverage for the bioretention areas is 5% of the entire paved surface. Proper engineering, design, and construction of these landscape features is mandatory, and their maintenance requirements are a little different from the normal parking lot landscape island. However, with appropriate plant selection, these small-scale plant communities can be almost self-sustaining and require less upkeep than a typical landscape bed.

As with any installed landscape, proper plant choices are essential to the long-term success of landscape islands. Trees must be able to withstand both drought and periodic flooding of their root systems, and should be deep-rooted. Trees should neither drip sap on vehicles, nor have large or messy fruit. If possible, trees that shed large, persistent leaves should be avoided in favor of those with small leaves that biodegrade quickly. All shrubs and herbaceous perennials used under trees in bioretention islands should

Table 1. Pollutant Removal Effectiveness of Stormwater Management Practices for Parking Lots.

Stormwater Management Practices	Pollutant Removal Effectiveness			
	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Metals
Bioretention Facilities	N/A	65%	49%	95–97%
Dry Swales	93%	83%	92%	70–86%
Surface Sand Filters	87%	59%	32%	49–80%
Infiltration Trench	N/A	100%	100%	N/A

N/A indicates that data is not available.

Adapted from: Winer, Rebecca. 2000. National Pollution Removal Data Base. Center for Watershed Protection, Ellicott City, MD 21043.

Table 2. Some landscape plants suitable for use in landscaped parking lot islands in Ohio and the upper Midwest. The plants listed here are mostly native to the Midwest, and there is some variation in their tolerance of flooding and winter salt. This list is only partial, and local nurseries or plant suppliers will be able to suggest other plants that will thrive in periodically flooded conditions or with poor drainage.

Scientific Name	Common Name	Remarks/Cultivars available	
Trees tolerant of intermittent flooding			
Acer x freemanii	Freeman Maple	'Armstrong', 'Autumn Blaze'	C
Acer rubrum	Red Maple	'Red Sunset', 'October Glory'	C
Aesculus glabra	Ohio Buckeye	May scorch in summer	N
Aesculus pavia	Red Buckeye	Good flower display	N
Alnus glutinosa	Common Alder	Multi-stem, fast-growing	N
Betula nigra	River Birch	'Heritage'	C
Carya cordiformis	Bitternut Hickory	Deep tap root, drops nuts	N
Celtis occidentalis	Common Hackberry	Large, very tough	N
Fraxinus americana	White Ash	Avoid fruit, with male clone only	N
Gleditsia triacanthos	Thornless Honeylocust	'Shademaster'	C
Magnolia virginiana	Sweetbay Magnolia	Semi-evergreen, fragrant	N
Nyssa sylvatica	Black Gum	Great fall color, deep taproot	N
Quercus bicolor	Swamp White Oak	Large, slow-growing	N
Quercus nigra	Water Oak	Dislikes alkaline soils	N
Salix alba	White Willow	'"Britzensis' has orange twigs	N
Taxodium distichum	Common Baldcypress	Very adaptable	C
Shrubs: suitable for shade, and for root competition with canopy trees			
Aesculus parvifolia	Bottlebrush Buckeye	Large shrub, showy flowers	N
Aronia arbutifolia	Red Chokeberry	'Brilliantissima'	C
Aronia melanocarpa	Black Chokeberry	Low-growing, showy fruit	N
Clethra alnifolia	Clethra or Summersweet	'Hummingbird'	C
Cornus sericea	Yellowtwig Dogwood	'Flaviramea': yellow in winter	C
Cornus stolonifera	Red osier Dogwood	Bright red winter twigs	N
Ilex verticillata	Winterberry	'Winter red' cultivar	C
Itea virginica	Virginia Sweetspire	'Henry's Garnet'	C
Rosa rugosa	Ramanas Rose	Hardy ground cover	I
Thuja occidnetalis	Arborvitae	Many forms available	C
Vaccinium macrocarpon	Cranberry	Evergreen with red fruits	C
Viburnum dentatum	Arrowwood Viburnum	'Chicago Luster'	C
Groundcovers and flowering perennials for wet and/orshady conditions			
Aegopodium podagraria	Bishop's weed	Variegated leaves; invasive	I
Arisaema dracontium	Greendragon	Deep shade	N
Asclepias incarnata	Swamp Milkweed	Full sun for best flowers	N
Aster lateriflorus	Farewell-summer	'Prince' cultivar is shorter	N
Carex spp.	Sedges—many kinds	Tolerate standing water	N
Cimicifuga racemosa	Black Snakeroot	Very tall flower spikes	N
Cornus canadensis	Bunchberry	Deciduous groundcover	N
Epimedium spp.	Epimedium	Various species, some showy	I
Euonymus fortunei	Wintercreeper	Evergreen, many cultivars	I
Eupatorium maculatum	Joe-Pye Weed	Tall with purple flowers	N
Geum canadense	White Avens		N
Iris versicolor	Blue Flag	Tolerates standing water	C
Juncus effusus	Soft Rush	Resembles grass	N
Liriope spicata	Creeping Lily-turf	Grass-like with lavender flowers	I
Lobelia cardinalis	Cardinal flower	Various colors available	C
Lysimachia nummularia	Creeping Jenny	Groundcover, yellow flowers	I
Mertensia virginica	Virginia Bluebells	Early spring flowers	C
Mitchella repens	Partridgeberry	Creeping, evergreen	N
Phlox divaricata	Wild Blue Phlox	Showy blooming, native	C
Ranunculus repens	Creeping buttercup	Flowering groundcover	I
Tradescantia virginiana	Spiderwort	Named garden varieties	C
• N = Native, indigenous to the upper midwest. • C = Cultivars (or hybrids) of native species are available. • I = Introduced to the United States.			

Figure 3. Photo of parking lot with established landscape islands for infiltration of runoff. (Courtesy of Prince George's County, MD)

be shade tolerant and, if winter salting is the norm, salt tolerant. Shrubs and perennials must be attractive at close range; weedy growth or sprawling habit can make the landscape appear unkempt. Evergreen leaves and showy flowers are a bonus. Maintenance for bioretention landscape islands is not much different from that required for a standard landscape island: annual testing of soil pH, mulching, inspection of plants for pests, pruning for shape and vigor, and regular litter removal. The specification of flood-tolerant woody and herbaceous perennial plants will ensure that any intermittent flooding is a benefit rather than a threat to plant health. Balanced combinations of both evergreen and deciduous flowering trees, shrubs, and herbaceous perennials or groundcovers, these plants can help turn the potential eyesore of detention basins into an asset for any public landscape.

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For an up to date list of web related references visit the Ohio NEMO web site at http://nemo.osu.edu

Acknowledgments

John Rozum, National NEMO Network; Laurie Giannotti, Connecticut NEMO; Jim Gibbons, UConn Cooperative Extension; and Jennifer Zielinski, Center for Watershed Protection for their review of the fact sheet.

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Section VII

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Hamilton County Storm Water Study

Overview

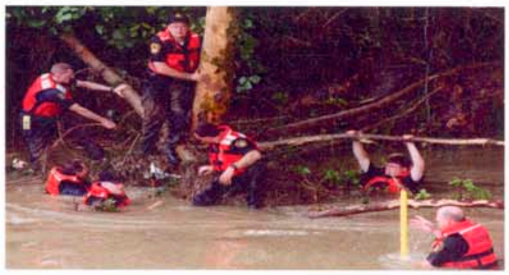
One of the most serious problems facing local elected officials today is storm water. Building flooding, erosion of stream banks, sewer back-ups,street closures are all issues that must be addressed on an all too frequent basis. On top of all these problems, local officials will soon be required to deal with the storm water quality issues associated with the USEPA NPDES Phase II Storm Water Permit Program.

Southwest Ohio and Hamilton County have experienced a rash of high intensity rainfall events in the last few years. Serious flooding has occurred in January, 2000 and July 2001. The July 2001 storm alone produced more than $9 million in damages and the loss of 3 lives in the County.

The NPDES Phase II Storm Water Permit Program will require most local governments to take action to improve water quality in the areas rivers and streams. Communities will be required to reduce the pollution load coming from their storm sewers and ditches.

To address many of these issues, local governments will have to revise zoning ordinances, establish more stringent controls on new construction, increase maintenance activities and in many cases establish new funding programs.

The following sections describe the Hamilton County Storm Water Study, the Steering Committee, the material considered and recommendations made by this Committee during the past year.



Rescue workers along Sycamore Creek July 18, 2001

February 6, 2002

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What happens if communities don't comply?	2
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Special points of interest:

- All local governments designated by USEPA must submit an NPDES Phase II Permit Application and Implementation Plan to OEPA by **March 10, 2003.**
- Preliminary estimate of the potential capital requirements would exceed $500 million.
- See bottom of page 4 for recommended actions

Hamilton County Storm Water Study

The Hamilton County Storm Water Study was initiated in 2001 to evaluate the feasibility of dealing with the NPDES Phase II Permit Program on a regional basis and to review the flooding and erosion control problems in Hamilton County.

A consulting team from FMSM Engineers, Environmental Rate Consultants, URS Corp. and Balke Engineers was selected to collect information and facilitate the planning process.

A kick-off meeting for the study was held on March 29, 2001. A Steering Committee was established with representatives from county departments, local governments, regional agencies and area universities.

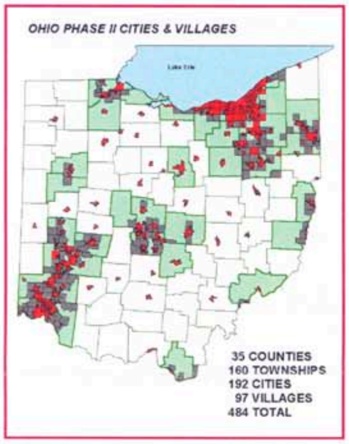
The Steering Committee has met monthly with an average of 45 people attending each meeting.

The Consulting Team presented a series of "Issue Papers" to assist the Steering Committee in evaluating alternatives. Much of the information contained in this document was included in these Issue Papers.

In July, as a result of the torrential rainfall and ensuing devastating flood, the Storm Water Study has shifted from a primary focus on establishing a regional Phase II permit application to also include a means to address some of the regional flooding and erosion control problems identified after the July flood.

During the course of this Study, nearly 500 "Areas of Concern" were identified by local governments as requiring some form of capital improvement to address the issue. The Hamilton County Department of Public Works has also identified over 2,900 buildings, in the Townships, within the 100-year floodplain. A very preliminary estimate of the potential capital requirements would exceed $500 million, including:

- $250 million for capital projects to address the local governments "Areas of Concern"
- $50 million as the local share of the potential costs to remove or mitigate structures in the 100-year floodplain, and
- $200 million as the local cost for the flood control component of the Mill Creek Tunnel Project.



Local governments in Ohio currently listed in the NPDES Phase II Storm Water Permit Program.

NPDES Phase II Permit

Today, there is a new emphasis on dealing with the quality of storm water. Since enactment of the Clean Water Act by Congress in 1972, local governments and industries in Ohio have spent hundreds of millions of dollars to upgrade, expand or rebuild their wastewater treatment plants. The net result of this massive capital program has been significantly improved effluents from wastewater plants with corresponding improvements in the quality of receiving streams. As these treatment plants have improved however, it has become apparent that there are other sources of pollutants to our rivers and streams that are adversely affecting their quality and impacting aquatic life. These "non-point" sources include agricultural runoff (fertilizers, pesticides), hydro modification (channelization, stream maintenance), mining, urban runoff, land disposal, construction site runoff and failing septic systems.

To address these non-point sources of pollution, U.S. EPA initiated the National Pollution Discharge Elimination System (NPDES) Phase I and Phase II storm water programs. The Phase I program required that major cities with populations greater than 100,000, which had separate storm sewer systems (does not include combined sanitary sewer and/or sanitary sewer systems) must obtain a permit from Ohio EPA by May 1993. In Ohio, only Columbus, Akron, Dayton and Toledo were required to obtain a Phase I permit. The other major cities meeting the population criteria were excluded from these regulations and fall under separate but related combined sewer system regulations.

On **December 8, 1999** US EPA adopted regulations that will require many of the remaining cities, villages, urban townships and counties to obtain NPDES Phase II storm water permits. Currently Ohio EPA estimates over 480 local governments across Ohio will be required to obtain a Phase II storm water permit. All affected entities must obtain permit coverage by **March 10, 2003**. These local governments will be required to develop a storm water management program (The permit is a storm water quality plan for the community) that implements six minimum control measures.

Commissioner John Dowlin, at the Workshop for elected officials, on January 10, 2002 asked those attending if :

" they have the political will to address storm water on a county-wide basis."

Six Minimum Control Measures

1. Public Education and Outreach
Distributing educational materials and performing outreach to inform citizens about the impacts polluted storm water runoff discharges can have on water quality.

2. Public Involvement / Participation
Providing opportunities for citizens to participate in program development and implementation, including effectively publicizing public hearings and/or encouraging citizen representatives on a storm water management panel.

3. Illicit Discharge Detection and Elimination
Developing and implementing a plan to detect and eliminate illicit discharges to the storm sewer system (includes developing a storm water system map and informing the community about the hazards associated with illegal discharges and improper disposal of wastes).

4. Construction Site Runoff Control
Developing, implementing and enforcing an erosion and sediment control program for construction activities that disturb one or more acres of land.

5. Post-Construction Management
The development, implementation and enforcement of a program to address the discharges of post construction storm water runoff from new development. Controls could include protection of sensitive areas (wetlands), or the use of structural BMP's.

6. Pollution Prevention /Good House Keeping
Developing and implementing a program to prevent or reduce pollutant runoff from municipal operations. The program must include municipal staff training on pollution prevention measures and techniques (e.g., regular street sweeping, and reduction in the use of pesticides or street salt, or frequent catch basin cleaning).

What happens if communities don't comply?

- **NPDES Permits are federally enforceable**
- **Noncompliance = Dollars and enforcement action**
    - **Civil Violations up to $25,000 per day**
    - **Ohio EPA can take enforcement action against local government**
- **Section 505—Any citizen can file a lawsuit against a discharger**

Legal Organizational Options

During the course of the Storm Water Study, there were seven legal structures under the Ohio Revised Code (ORC) that were evaluated to create an organization best suited to address the NPDES Phase II regulations, including:

- 167 Regional Council of Governments;
- 700 Municipal Corporations.
- 6101 Conservancy Districts;
- 6105 Watershed Districts;
- 6115 Sanitary Districts, and
- 6117 Sewer Districts;
- 6119 Regional Water and Sewer Districts;

The criteria utilized by the Steering Committee in evaluating these structures included:

- Ability to organize in one or more counties;
- The ORC Chapter applies to storm water management;
- Formation procedure(s);
- Management structure;
- Political Subdivision status;
- Procedure(s) for joining and leaving the District;
- Ability to assess properties for specific projects;
- Ability to charge user fees;
- Use of funds for operations, maintenance, and capital improvements;
- How to recover the costs associated with forming the District;
- Ability to give and receive loans;
- Ability to accept grants from governmental or other agencies;
- Ability to issue bonds in anticipation of future revenue;
- Ability to create/organize sub-organizations;
- Ability to establish and enforce regulations;
- Ability to meet the six minimum control measures, and
- The type of NPDES Phase II permit available to the District.

Erosion Damage along Polk Run from storm of July 17—18, 2001

Alternate Management Strategies

Based on the criteria listed above, the Steering Committee agreed by consensus that there were two management structures that could best address regional storm water management issues in Hamilton County, these being:

1. County Sewer District ORC 6117, or
2. Regional Water and Sewer District ORC 6119

The adjoining table illustrates the primary differences between these two legal structures:

	ORC 6117	ORC 6119
Include more than one county	No	Yes
Applicable to storm water	Yes	Yes
Formed by	County Comm.	Court
Direction from	County Comm.	Members
Political Subdivision	Yes	Yes
Choice to leave District	County Comm.	Board
Ability to Assess property	Yes	Yes
Collect User Fees	Yes	Yes
Planning costs	Assessment	Assessment
Loans, grants & bonding	Yes	Yes
Form sub-organizations	Sub-districts	Sewer Districts
Establish & enforce rules	Yes	Yes
Meet 6 minimum controls	Yes	Yes
Form of Permit	Regional watershed	Regional watershed

Other Storm Water Programs

The Steering Committee evaluated three examples of other storm water programs in the Midwest that are currently in operation or in the process of being formed, including the:

1. Maumee River Regional Storm Water District (MRRSWD) in the Toledo area,
2. Lake County Illinois, and
3. Louisville - Jefferson County Kentucky.

The adjoining table illustrates the relative size, level of service provided and cost of each of these programs.

Location	Number of Employees	Level of Service	Annual Budget	Annual cost / household
Toledo area (MRRSWD)	5	Phase II only	$ 1.2 M	$5.00 -$10.00
Lake Co., IL	18	Phase II + capital	$ 7 M	$5.04
Louisville, KY	100+	Phase II + capital + O&M	$ 18 M	$43.80

The table to the right is a summary of other storm water programs in the United States. Most of these programs vary by the level of service they provide. They have been classified as small, medium or large depending on their population served, annual budget and level of service provided.

Most of the Storm Water Districts in the Midwest are charging $2.00 to $4.00 per ERU, (Equivalent Residential Unit). An ERU is generally determined by the average number of square feet in a residential home. This is then used as an estimate of the impervious surface, (portion of the property that would runoff to the storm sewer system), during a rainstorm. Once an ERU is determined for a community, then all other structures, whether commercial or industrial, can be charged based upon their equivalent ERU.

A preliminary estimate of the monthly and annual cost per ERU in Hamilton County was prepared based on population and parcel information. A much more detailed cost of service analysis would be required to actually set rates based upon the level of service provided and an impervious area analysis. The estimated rates include:

Small District 1 - 9 employees,
just NPDES Phase II Permit,
annual cost $ 0.8 - $ 2.0 M,
$ 1.20 - $ 3.00 per ERU

Medium District 10 - 50 employees
Phase II and some limited capital project
$ 8.0 - $ 16.0 M per year,
$12.00-$24.00 per ERU.

Large District over 100 employees
Phase II, regional capital plus O & M.,
$ 25.0 - $ 34.0 M per year
$ 36.00 - $ 48.00 per ERU

Location	Population	Size	Capital Budget	Total Budget	Monthly Cost / ERU	Annual Cost / ERU
MRRSWD	560,000	small	0	$1..2m	$0.5-$1.0	$5 -10.00
Lake Co. IL	600,000	medium	2m	$7m	$0.42	$5.04
Louisville KY	800,000	large	7m	$18m	$3.65	$43.80
Cincinnati OH	365,000	medium	4m	$7.2m	$2.21	$26.52
Forest Park OH	20,500	small	0.3m	$0.62m	$3.00	$36.00
Toledo, OH	300,000	large	3m	$9.5m	$3.16	$37.92
Columbus, OH	500,000	large	5m	$12m	$2.21	$26.52
Ft Wayne, IN	200,000	small	0.4m	$4m	$1.80	$21.60
Dayton, OH	170,000	medium	0	$3.2m	$2.18	$26.16
Mason, OH	30,000	small	1m	$2m	$3.00	$36.00
Sacramento, CA	410,000	large	?	?	$10.98	$131.76
Bellevue WA	106,000	large	8.4m	$42.8m	$9.06	$108.72
Seattle, WA	564,000	large	?	$13m	$14.17	$170.04
Portland, OR	504,000	large	9.4m	$21.3m	$7.32	$87.84
Austin, TX	660,000	large	5m	$20m	$3.65	$43.80
Tulsa, OK	393,000	large	?	$12m	$2.95	$35.40
Salt Lake, UT	182,000	medium	?	$5m	$3.00	$36.00

Steering Committee Recommendations

On January 10, 2002, a Workshop was held for local elected officials and administrators. One-hundred eighteen persons representing thirty-seven of the fifty local governments attended this Workshop. Following a presentation by the Consulting Team, Commissioner John Dowlin asked the group if there was an interest in establishing a countywide Storm Water District to deal with the Phase II Permit and the flooding problems. The response was extremely positive.

The Storm Water Steering Committee, at their meeting on January 11, 2002, discussed the need to take immediate action to address the NPDES Phase II Permit on a regional basis. The members expressed concern that establishing a Storm Water District to address both the flooding problems and the NPDES Phase II Permit issues could take a substantial amount of time which might cause some jurisdictions to proceed with preparing an application individually.

The Steering Committee on January 11, 2002 recommended the following:

1. The Board of Hamilton County Commissioners establish a County Storm Water District under Ohio Revised Code Section 6117, to address the immediate issue of preparing a county-wide permit application and implementation plan to meet the USEPA NPDES Phase II permit application deadline of March 10, 2003, and

2. Establish an Executive Committee consisting of a Hamilton County Commissioner, local elected officials selected by the Hamilton County Municipal League and Township Association, and the City of Cincinnati, along with the County Engineer and the Director of MSD to analyze and recommend the future level of storm water service and costs of services to be provided by the Storm Water District, to involve and encourage participation by local governments in this District and ultimately make a recommendation to the County Commissioners. *

Storm Water Study Steering Committee

* Note: Participation in this Storm Water District by a municipal corporation shall first be authorized by an ordinance or resolution of the legislative authority of the municipal corporation.

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Hamilton County Regional Planning Commission

138 E. Court Street, Rm 807
Cincinnati, OH 45202
(513) 946-4500
www.planningpartnership.org

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